PAPER TRADE
JOURNAL

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November 13, 1953

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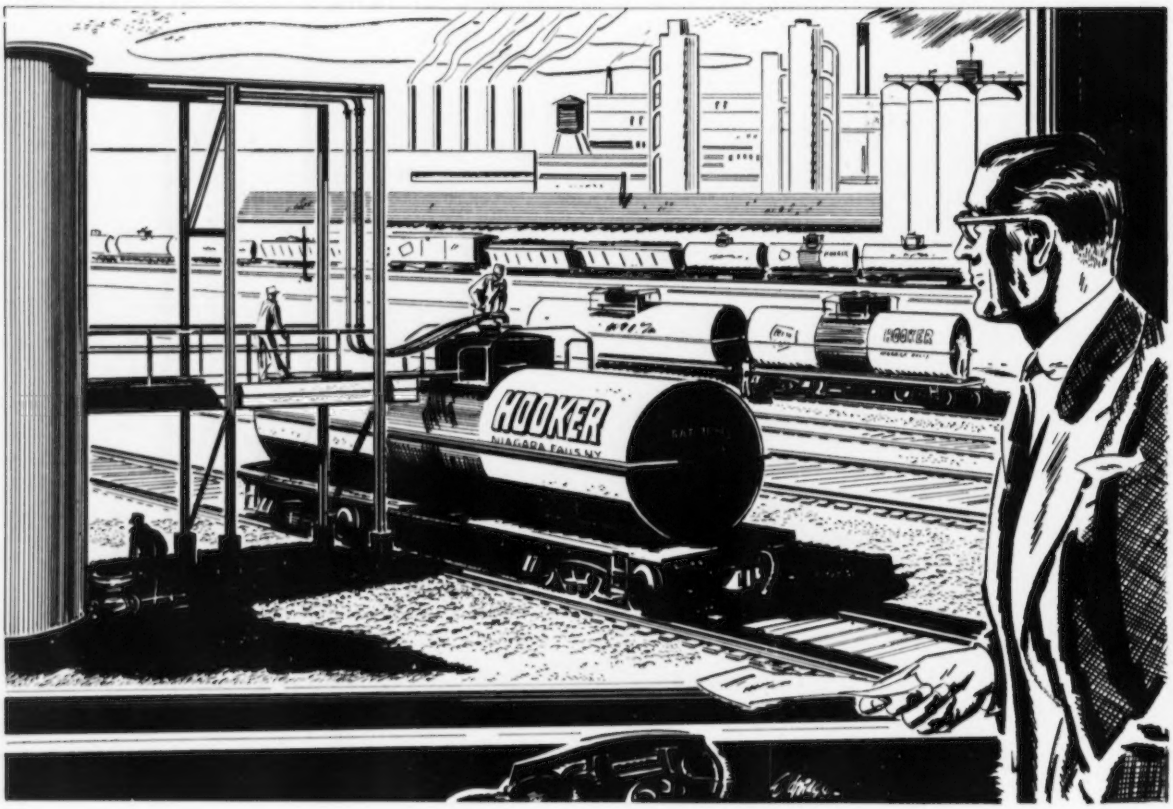

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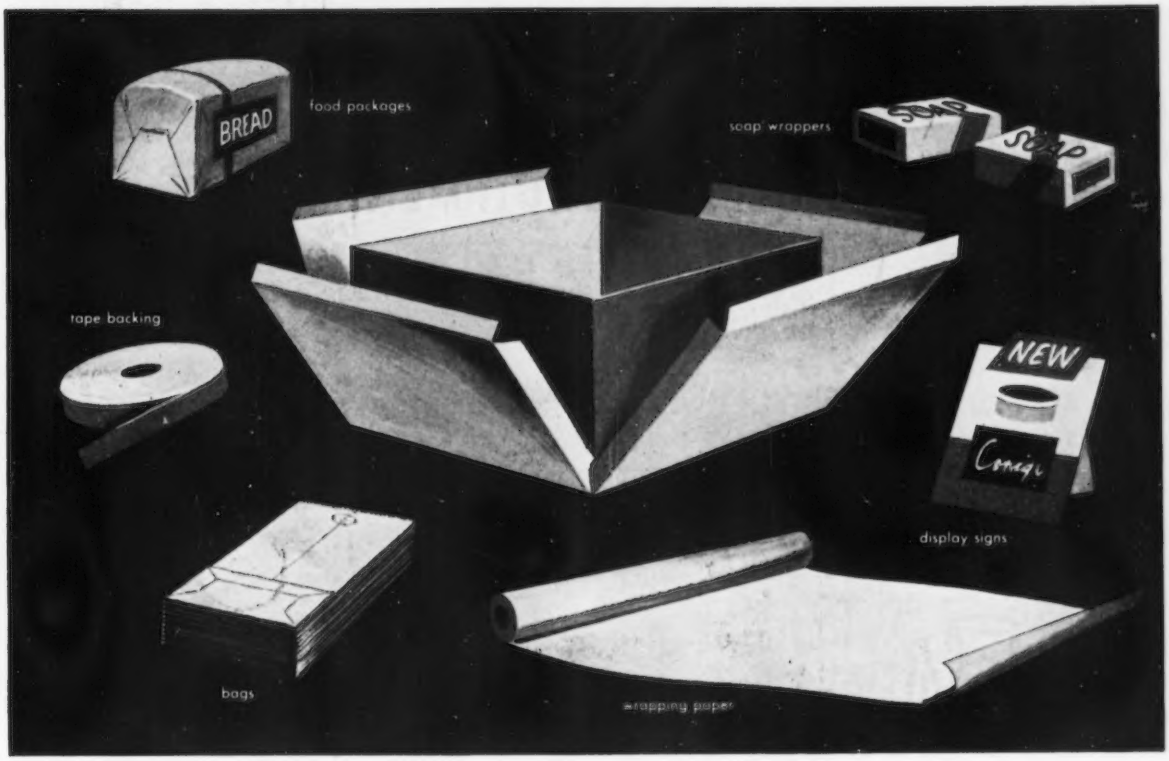

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REMEMBER THESE DATES

NOV. 18-20: 7th TAPPI Alkali Pulping Conference, Rice Hotel, Houston, Texas.

JAN. 27-29, 1954: Technical Section Annual Meeting, C.P.P.A., Sheraton-Mount Royal Hotel, Montreal, Que.

FEB. 14-19: Annual Meeting, APPA, Waldorf-Astoria Hotel, New York, N. Y.

FEB. 15-18: Thirty-ninth Annual Meeting, TAPPI Commodore Hotel, New York, N.Y.

JUNE 21-25: National Meeting, APPMSA, Sheraton-Mount Royal Hotel, Montreal, Que.

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Published Weekly Since 1872

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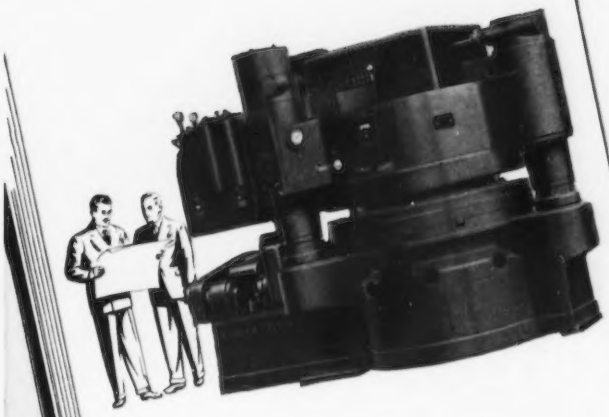

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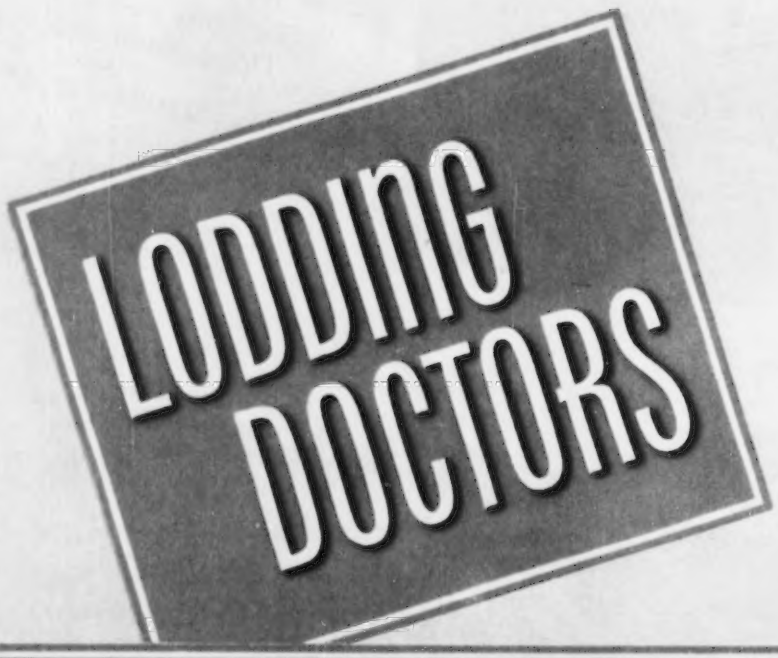

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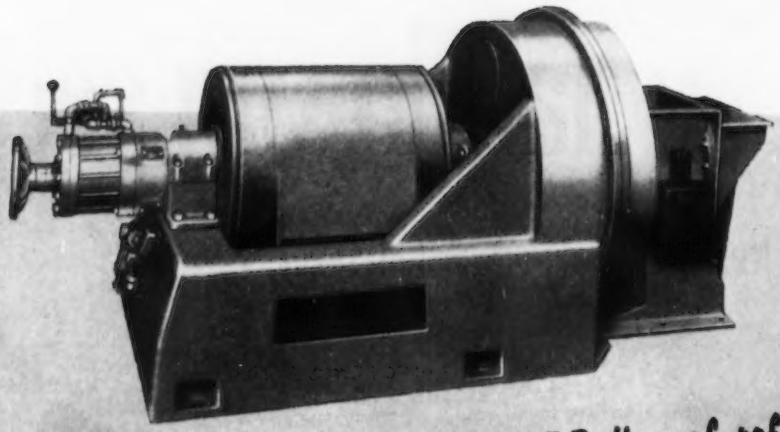

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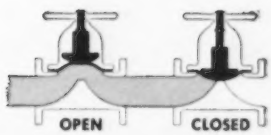

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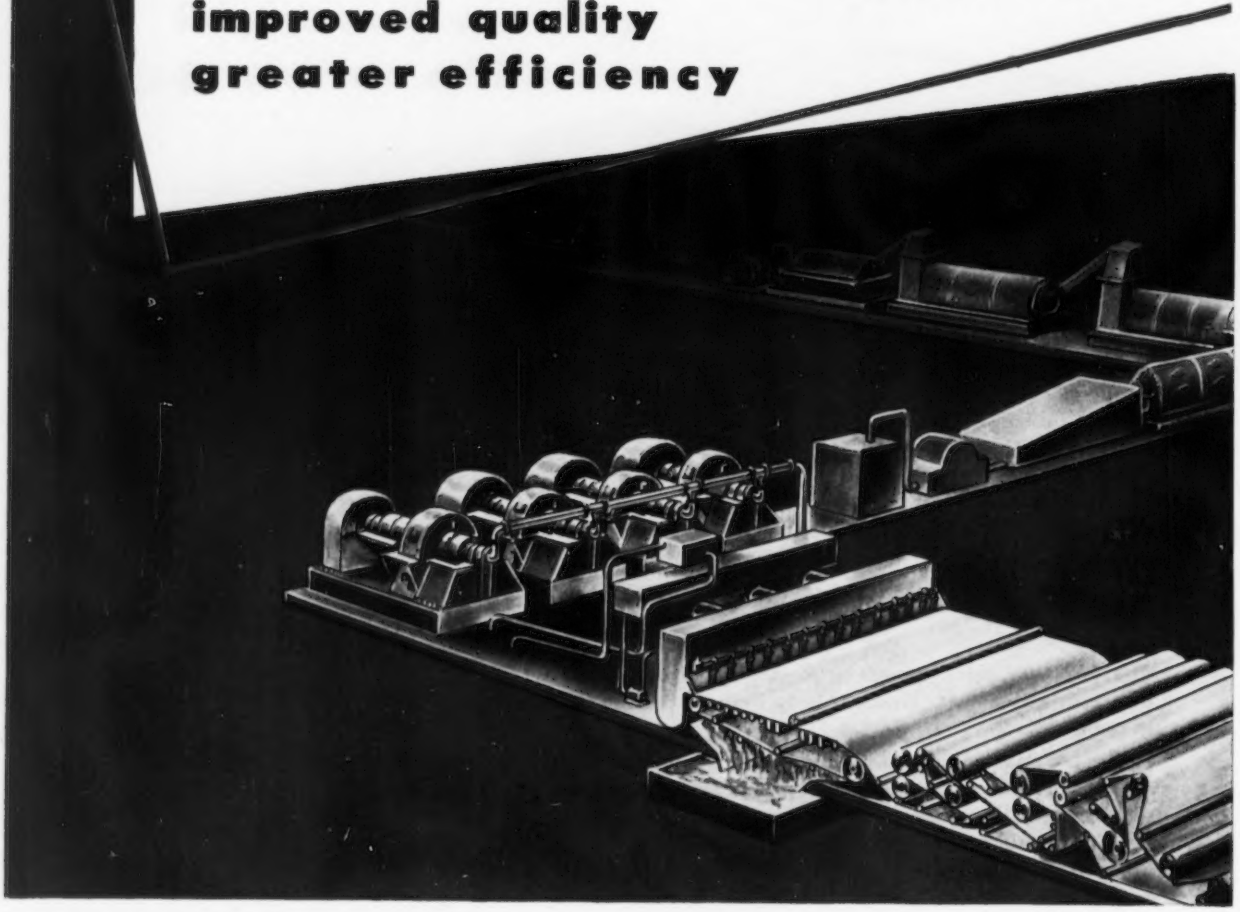
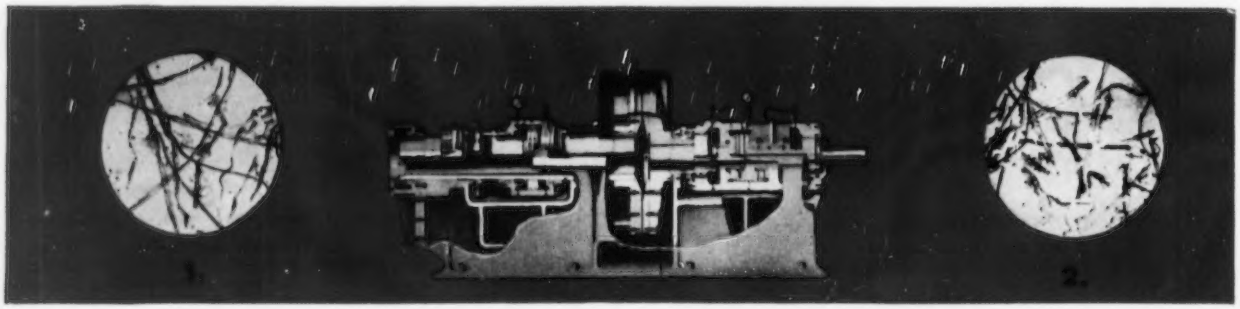


FIGURE 1. A typical Sutherland-treated pulp. Note the length of the fibrils, many of which are still attached to the parent fibers. Thoroughly beaten and refined, the fibers have, nevertheless, not been seriously weakened and chopped up in the process.

FIGURE 2. The effect produced by a Jordan on the same pulp at the same freeness. It can be seen that the fibers have been chopped up into segregated fines, impairing fiber quality and sacrificing many desirable qualities in the finished product



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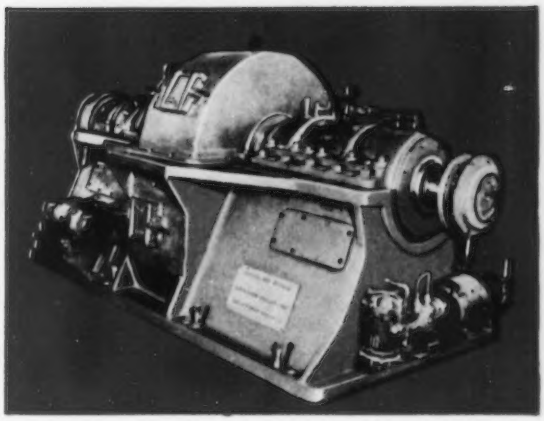

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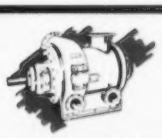

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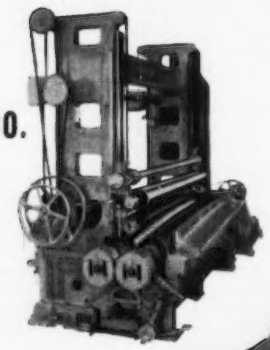

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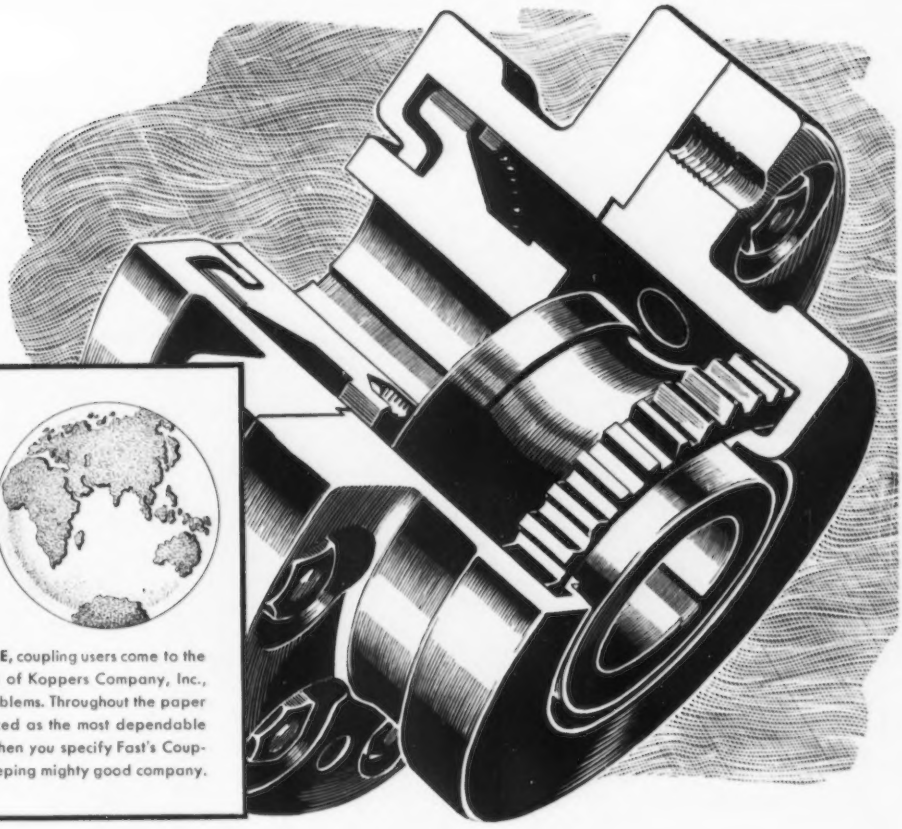

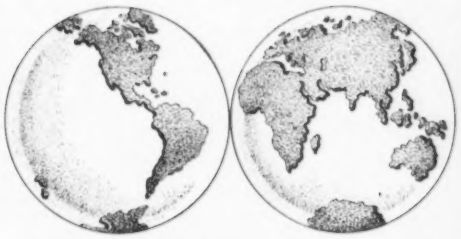

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Write today for full details on Fast's Couplings and Koppers Engineering Service to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 371 Scott Street, Baltimore 3, Maryland.

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FAST'S Couplings

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE, MD. This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Koppers-Elex Electrostatic Precipitators, Aeromaster Fans and Gas Apparatus.

Engineered **Products Sold with** *Service*

KOPPERS COMPANY, INC., *Fast's Coupling Dept.,* **371 Scott St., Baltimore 3, Md.**

Gentlemen: Send me a Fast's Catalog giving detailed descriptions, engineering drawings, capacity tables and photographs.

Name .....

Company .....

Address .....

City ..... **Zone** ..... **State** .....

A few rolls of wallpaper can transform your rooms into places of warmth . . . of beauty . . . of individuality. That's the magic of wallpaper—and of wood pulp.

Some of the finest wallpapers in American homes everywhere are made from Brown Company pulps—pulps carefully engineered to provide many special qualities—color stability to prevent discoloration, good aging characteristics for permanent wear, durability against drying and cracking, etc.

Coming up with the *right* pulps for special papers like wallpaper is a job our Technical Service Division has been doing for more than half a century. If you have a paper problem of any kind, perhaps we can help you, too. Write to Dept. PB-11 in our Boston office.

BROWN COMPANY, Berlin, New Hampshire
CORPORATION, La Tuque, Quebec

General Sales Offices: 150 Causeway Street, Boston 14, Mass.
Dominion Square Bldg., Montreal, Quebec

Visit us at Booth 222, 24th Exposition of Chemical Industries, Philadelphia, November 30—December 5.

Did you ever see an ad— WALKING?

Every time an attractive parcel leaves a store—*it goes as an ad that can bring in more trade.*

The store owner depends on the package's unusual color and design to set his store apart from competition as a place of distinctive personality. Remind him that such a package brings to mind not just the idea of shopping . . . but of shopping at HIS STORE—*specifically!* That way, you'll be giving him the kind of help that brings in *new* orders for you.

And by introducing colors that look "tailor-made" for your customers, you'll gain a hold on your market that will result in more *re*-orders, too! Du Pont's technical-service experts will help you give stores truly distinctive packaging colors that they'll want to keep using year after year—packaging they'll buy from *you* consistently!

For details—and for information about the hundreds of shades of colors that you can use for wrapping paper, bags, boxes and gummed tape—write E. I. du Pont de Nemours & Co. (Inc.), Dyes and Chemicals Division, Wilmington 98, Delaware.

FOR MAXIMUM ECONOMY Du Pont basic dyes

FOR MAXIMUM SOLUBILITY Du Pont acid dyes

FOR MAXIMUM LIGHT FASTNESS
Du Pont dispersed organic pigments:
Monastral* Fast Blues Monastral* Fast Greens Lithosol* Pigments

*REG. U. S. PAT. OFF.

More color makes more business . . . for your customers and you

Du Pont Dyes

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1. Westinghouse Application Engineer
2. Westinghouse Sales Engineer
3. Chief Engineer
4. Electrical Engineer
5. Production Superintendent

Your motor and control problems are local ... so is Westinghouse application assistance

Do you put a full team on the field when you tackle a motor and control application problem? Are you cashing in on the know-how of your local staff of Westinghouse application engineers? Take a look at this line-up:

Your local Westinghouse sales engineer has a broad knowledge of all Westinghouse Motors and Controls. He knows their capabilities and limitations. He knows how to match motors and controls for maximum production.

Your local Westinghouse application engineer is equipped to analyze any motor and control problem and then develop the best solution. He can handle any application problem from a simple machine tool to a complete production line.

Your local Westinghouse product engineer is a specialist in one type of motor or control. These men work at the local level but operate from a manufacturing headquarters office.

Enlist the services of these men on your next motor and control application job. Call your local Westinghouse office for further details, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21746

Application engineers work out of 126 Westinghouse offices

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Smooth Board Sells and Stays Sold!

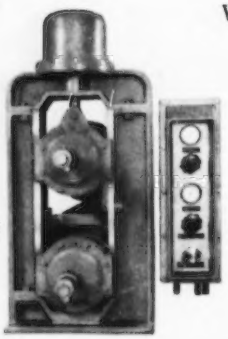
Improve your finish with a Manchester Smoothing Press

Here is the simplest, surest smoothing press ever designed—one that will give you *uniformly smooth board* on all your orders.

Your customers will like the consistently smooth surface you can give them with a Manchester Smoothing Press, even for exacting multi-color press work. This means satisfied users, repeat sales, better profits.

Note these important features of the Manchester Smoothing Press. It is simple, has no unnecessary moving parts. It is easy to install, easy to operate. Completely air-controlled, it offers you final proof of its efficiency in *greatly improved finish and uniform caliper of board.*

Look into the Manchester Smoothing Press today. Write for all the facts.



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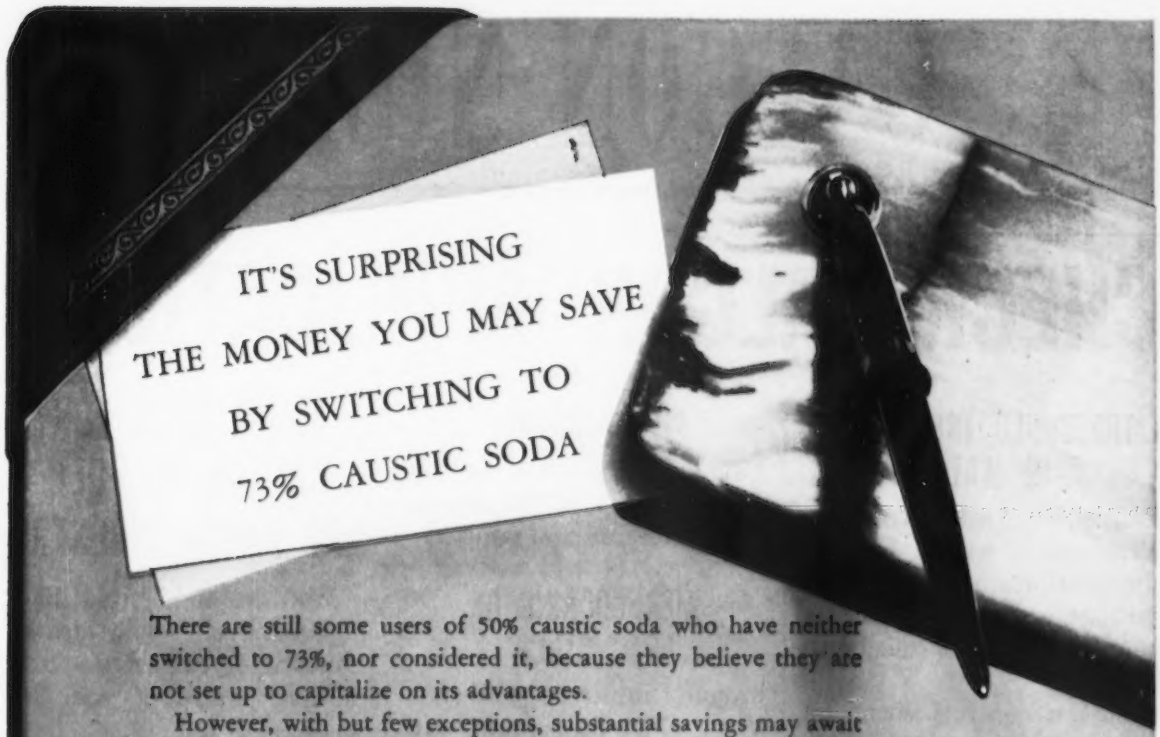

There are still some users of 50% caustic soda who have neither switched to 73%, nor considered it, because they believe they are not set up to capitalize on its advantages.

However, with but few exceptions, substantial savings may await only the responsible person's decision to compare costs.

The amount of caustic soda you consume naturally influences the savings, but even small users may be able to save up to $1000 annually. Some large users save $35,000 per year and more. Your plant location also plays an important part in the amount of savings.

But it costs you nothing to find out now. Our technical staff will be glad to help you figure savings and to make recommendations. Call or write today!

DRY CAUSTIC USERS

Have you refigured your delivered costs of dry vs. liquid caustic soda in the light of recent increases? Many Columbia-Southern consumers are now realizing *substantial savings* by converting from flake to liquid. Initial cost of the installation required is low, usually paying for itself in savings within one year. Write us for details.

COLUMBIA-SOUTHERN CHEMICAL CORPORATION

SUBSIDIARY OF PITTSBURGH PLATE GLASS COMPANY
ONE GATEWAY CENTER, PITTSBURGH 22, PENNSYLVANIA

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CALGON NEWS

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CHECK CALGON* APPLICATIONS

THRESHOLD TREATMENT OF WATER

Calgon, when added to a high bicarbonate water, inhibits the precipitation of calcium carbonate when the water is heated or is treated with alkali.

Calgon controls corrosion of pipe lines . . . reduces iron pickup to less than 0.1 ppm.

CALGON DISPERSES PIGMENTS

Calgon's dispersive effect on clay, titanium dioxide, precipitated calcium carbonate and other pigments is of value to paper-coating mills where these pigments are incorporated in coating mixtures.

CALGON IMPROVES COATING COLORS

In coating paper, Calgon assists both the spreading and flow properties of the coating color and the bond of the coating to the paper stock.

CORROSION OF CALENDER STACK ROLLS

Calgon protects calender stack rolls from corroding and pitting when in continuous contact with water.

PITCH CONTROL

Calgon's dispersive action controls pitch in the manufacture of pulp and paper.

KIER COOKING OF RAG STOCK

Calgon improves whiteness . . . eliminates scum and stains in the kier cooking of cotton or linen rags, where caustic soda or soda ash is the alkali used in the cooking liquor.

WASHING DE-INKED PAPER STOCK

Calgon prevents harmful scale formations when washing de-inked paper stock and alkaline pulps.

SYNOCA

Several years of use have proved that felts washed with SYNOCA (Calgon felt washing compound) are superclean, softer, more absorbent, even on dirtiest felts.

BLEACHING GROUND-WOOD PULP

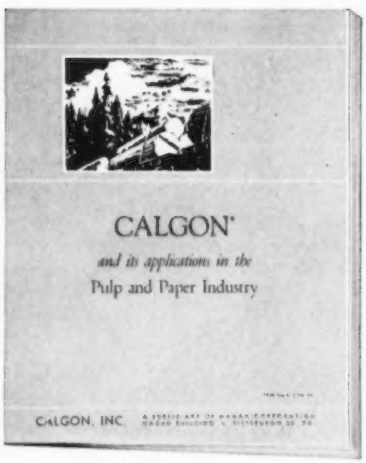
Calgon inhibits the breakdown of peroxide bleach liquors in the bleaching of ground-wood pulp.

MANY USES FOR CALGON IN PULP AND PAPER INDUSTRY

We have highlighted them here to give you an idea of how Calgon can serve you in various phases of your industry.

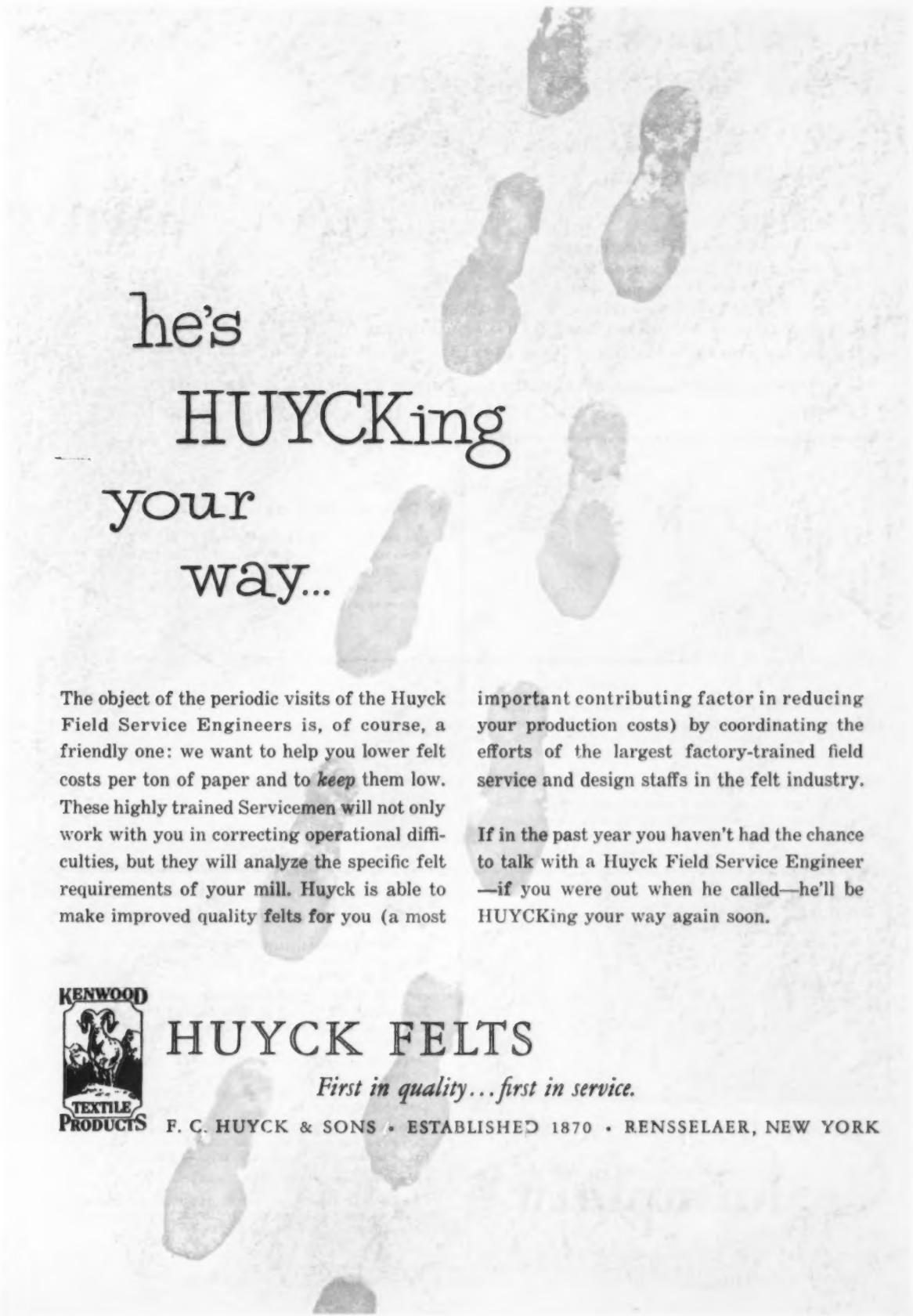
We will be glad to give you detailed information if you will write and tell us your problem.

Calgon, Inc., Hagan Building, Pittsburgh 30, Pennsylvania. *A Subsidiary of Hagan Corporation.*



Write for your free copy of "CALGON and its applications in the Pulp and Paper Industry."

*T. M. Reg. U. S. Pat. Off



he's HUYCKing your way...

The object of the periodic visits of the Huyck Field Service Engineers is, of course, a friendly one: we want to help you lower felt costs per ton of paper and to *keep* them low. These highly trained Servicemen will not only work with you in correcting operational difficulties, but they will analyze the specific felt requirements of your mill. Huyck is able to make improved quality felts for you (a most important contributing factor in reducing your production costs) by coordinating the efforts of the largest factory-trained field service and design staffs in the felt industry.

If in the past year you haven't had the chance to talk with a Huyck Field Service Engineer —if you were out when he called—he'll be HUYCKing your way again soon.

KENWOOD TEXTILE PRODUCTS

HUYCK FELTS

First in quality... first in service.

F. C. HUYCK & SONS • ESTABLISHED 1870 • RENSSELAER, NEW YORK

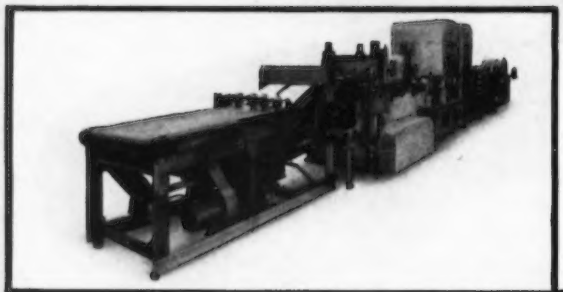
Hallmark of the finest printing and converting equipment...

Champlain

Rotogravure

High-speed precision-register printing on practically *any* stock in *any* practical multiple of colors. Meet the ever-increasing demand for more and better wrappers, labels, and cartons for packaged goods with Champlain *inline* rotogravure. "Speedry" ink fountain insures true reproduction of color and instantaneous drying. Print from roll stock 8" to 44" wide.

To complete a* CHAMPLAIN *rotogravure press—a* CHAMPLAIN *inline precision delivery unit:

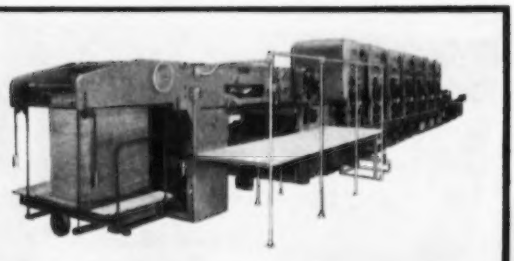


Cutting and Creasing Press

In one pass – only *once* through the press – it cuts, creases, and automatically yet thoroughly strips 7,500 to 10,500 cartons per hour from a continuous web. Platen press quality at *better* than cylinder press speeds.

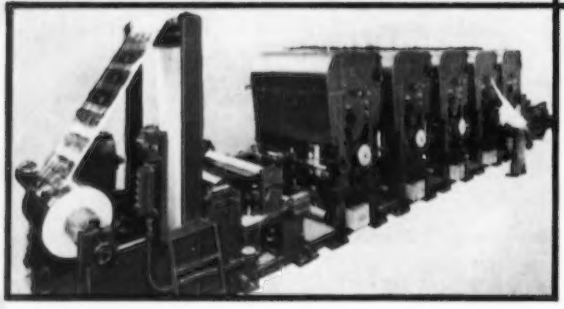
Sheet Delivery

Delivers from 8,500 to 12,500 square cut sheets per hour with 1/64" accuracy. *Faster than any other standard sheeter.* Positive sheet handling eliminates damage. No waste trim



Rewind Press

Hydraulically-actuated constant-tension roll unit rewinds from 400 to 800 ft. per min. Positively synchronized to press for balanced speed, tension, and control. Single, multiple, and staggered-roll models.



PLUS ***– a complete line of other equipment for all printing and converting needs.***

LETTERPRESS PRESSES, FLEXOGRAPHIC PRESSES, SPECIALTY PRESSES—for Tag, Chart Paper, End and Bakery Seals, Die Cut Labels.

CUTTING AND CREASING EQUIPMENT—Roll Fed Swing-Type Reciprocal and Stationary Die Cutting Presses – Vertical Extruding and Eccentric Punches and Perforators—Rotary Blankers.

SPECIALTY CONVERTING EQUIPMENT FOR INLINE USE—Rotary Embossers – Perforators and Score Units – Slitting Equipment – Hot Melt Thermoplastic Applicators – Special Delivery Equipment.

AUXILIARY EQUIPMENT – Automatic Electronic Register Controls (for multicolor and fabrication register on roll-fed equipment) – Automatic Web Splicers.

... and for special engineered equipment:

Champlain's ability to design and build special units is based on years of experience in developing inline printing, fabricating, and delivery equipment.

Champlain

Write today for catalog of Champlain equipment. Champlain Company, Inc.
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keen?

Keen judgement can save you a peck of trouble when it comes to buying waxes. Find out about the improved Pacemaker Waxes. Write to the Cities Service Wax Department K33, Sixty Wall Tower, New York 5, New York.

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Thiele Kaolin

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- Standardized Low Viscosity .
- Excellent Color . . . . . .
- High Brightness . . . . . .

Write for full information and sample of Thiele Kaolin coating or filler clay for your particular use.

Thiele Kaolin Company

P. O. BOX 270 · SANDERSVILLE, GA.

New mixing method delivers

Uniform 6% Stock

for faster processing, lower costs

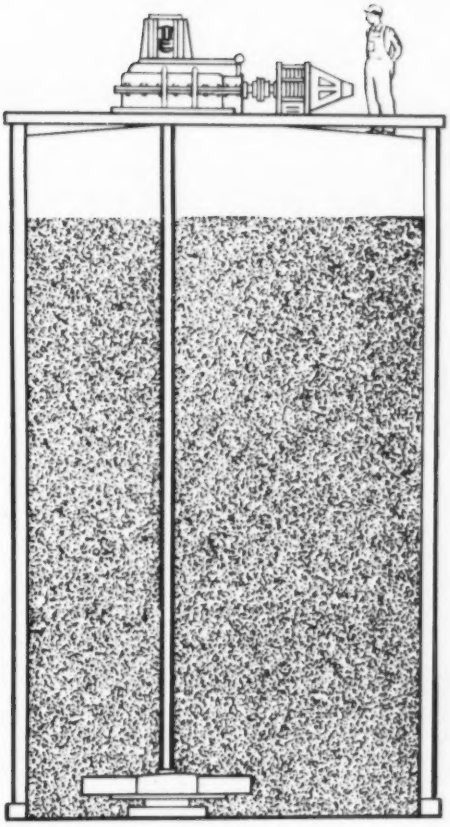
Here is a simple way to solve common problems of consistency, so often traceable to the stock chest.

Don't be satisfied with *half-mixed* stock. You can have fully uniform stock consistencies up to 6% from your stock chests —by using the LIGHTNIN mixing method shown here.

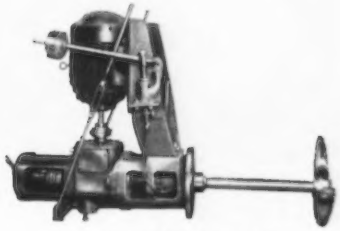
LIGHTNIN Mixers, properly installed, deliver the uniform high consistencies that your beaters and jordans are designed to handle best. LIGHTNINs enable you to predict—and control—stock consistency so accurately that stock dilution following the chest is practically unnecessary, and refining machines seldom, if ever, need to be reset.

And with uniform consistency stock coming through, the problem of diluting stock at the headbox is greatly simplified. Fewer safety measures are needed. You have much closer control over paper quality.

Plan now to investigate LIGHTNIN Mixers for your stock chests. For full information, write us today.



THIS KIND OF STOCK CHEST can deliver *fully uniform 6% stock* that processes faster and requires fewer control measures through the mill. Chest needs no baffles or midfeather; is simple to build and maintain. Mixing is done by a LIGHTNIN turbine-type mixer, carefully sized to mix the whole chest, or just the lower part of the chest, to *full uniformity*. These LIGHTNIN Mixers are supplied in sizes to 500 HP. They are factory assembled, fully guaranteed.



FOR RECTANGULAR CHESTS and smelt dissolving tanks. LIGHTNIN Side Entering Mixers are exceptionally easy to repack. Choice of stuffing boxes or mechanical seals. Sizes 1 to 25 HP.

FOR COATINGS, ADDITIVES and mixing chemicals. LIGHTNIN Portable Mixers clamp on any open tank or vessel. Thirty models to choose from. Sizes ⅛ to 3 HP.

Lightnin® Mixers

Get these helpful LIGHTNIN Catalogs

This library of mixing information is yours for the asking. Catalogs contain helpful data on impeller selection; sizing; best type of vessel; valuable installation and operating hints complete description of LIGHTNIN Mixers.

MIXCO fluid mixing specialists

MIXING EQUIPMENT Co., Inc.
173 Mt. Read Blvd., Rochester 11, N. Y.
In Canada: William & J. G. Greey, Ltd., Toronto 1, Ont.

- ☐ DH-50 Laboratory Mixers
- ☐ B-75 Portable Mixers (electric and air driven)
- ☐ B-102 Top Entering Mixers (turbine and paddle types)
- ☐ B-103 Top Entering Mixers (propeller type)
- ☐ B-104 Side Entering Mixers
- ☐ B-105 Condensed Catalog (complete line)
- ☐ B-107 Mixing Data Sheet

Please send me the catalogs checked at left.

Name_____

Title_____

Company_____

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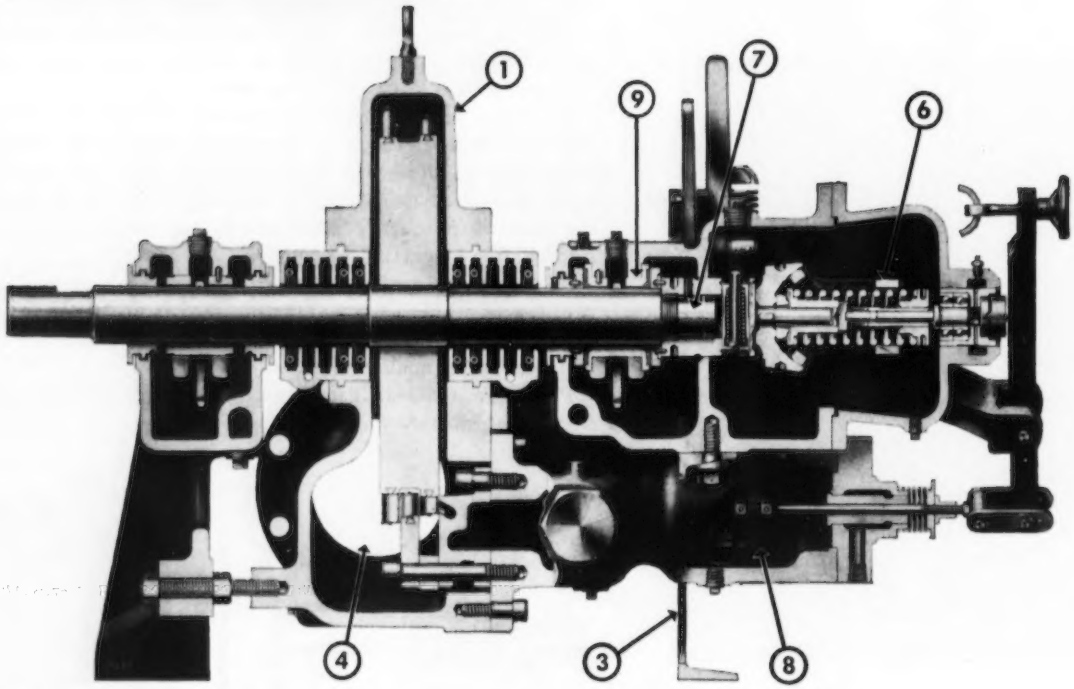
City_____ State_____

NEW **DE LAVAL**

HCB

SINGLE STAGE TURBINE

can be ordered from stock



1 Case and Cover Split Horizontally on centerline for ease of maintenance.

2 True Centerline Casing Support assures distortion-free radial expansion. *Not shown.*

3 Flexible Support at governor end provides for axial expansion.

4 Exhaust Opening either right or left side for installation flexibility.

5 Steam Strainer, protecting trip and governor valves, is *removable* for cleaning without breaking steam connections. *Not shown.*

6 Constant Speed Governor features governor weights pivoted around frictionless surfaces.

7 Complete Governor Assembly is now *replaceable as a unit.*

8 Balanced Single Seated Main Governor Valve has proportional flow characteristics for sensitive, positive control.

9 Shaft Locating Bearing of adjustable double collar type.

Horsepower: 100 MAX
Steam Pressure: 300 PSIG MAX
Steam Temperature: 550F MAX
Exhaust Pressure: 25 PSIG MAX
Speed: 4,000 RPM MAX
Steam Inlet: 2"–250# ASA FLG.
Exhaust: 6"–150# ASA FLG.
Weight: 1,200 LB.

Here's the new De Laval HCB Single Stage Turbine which is now "on the shelf" . . . ready for immediate shipment. This mechanical drive turbine is simple, rugged, designed for long economical life and low maintenance. For example, note the true centerline casing support, the replaceable governor, the removable steam strainer. Investigate all the advantages of this versatile driver. It is ready to handle—*at low cost*—a variety of applications in your plant.

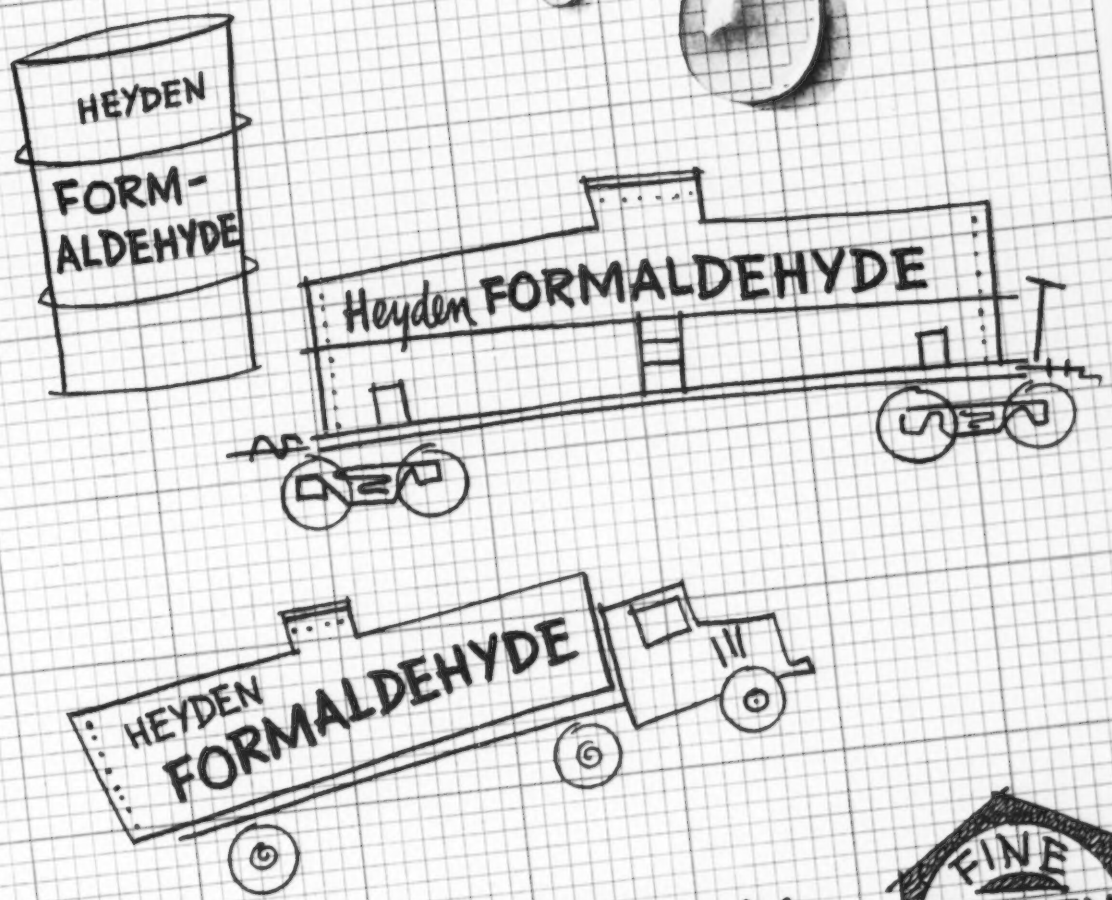
Send for new Bulletin 4206
which gives vital facts and figures

DE LAVAL *Mechanical Drive Turbines*

DE LAVAL STEAM TURBINE COMPANY
812 Nottingham Way, Trenton 2, New Jersey

DL209

HIGHEST QUALITY IN EVERY DROP



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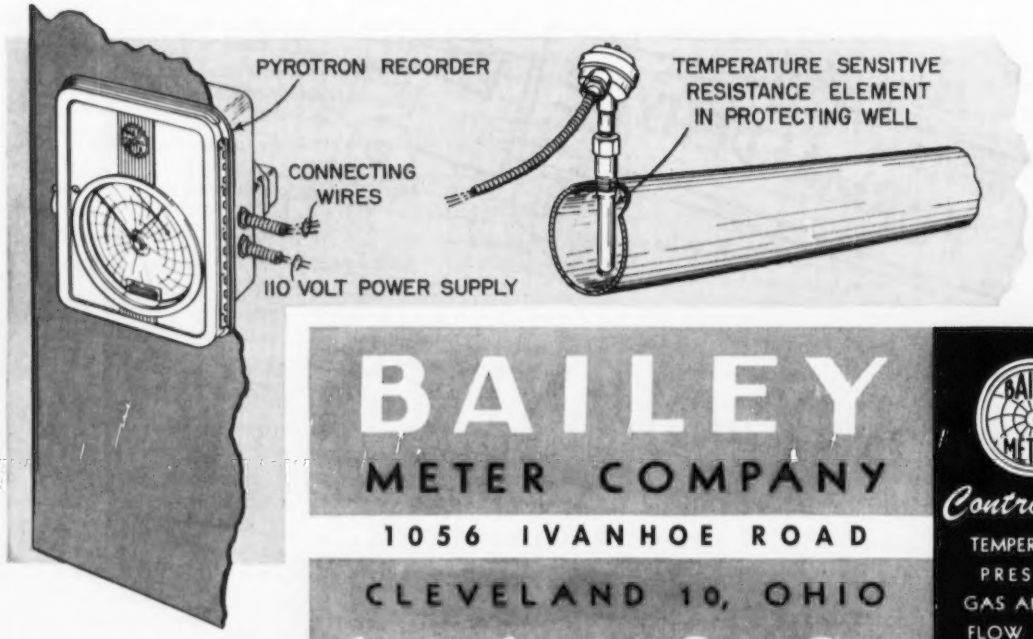
Your best buy for Precision Temperature Measurements In the -300F to 1200F Range

Check These Exclusive Bailey Advantages of Resistance Thermometer Operation

- ✓ Resistance thermometer operation over a complete range from —300F to 1200F has been made possible by Bailey's development of a low-cost platinum resistance element.
- ✓ Resistance thermometer operation requires no standard cell, dry battery and cold junction compensator. Uses 115 volt a-c source. Strong signal and high precision of resistance element as compared to thermocouple makes possible the use of narrow range spans.
- ✓ The Bailey Pyrotron is calibrated at the factory and *remains* accurate; no periodic re-calibrations required. Since all elements are matched it is not necessary to calibrate each recorder to its element.
- ✓ Recorder is sensitive to 1/10 of 1% of range span.
- ✓ Ordinary copper lead wires permit remote location of recorder with respect to the temperature sensing element.
- ✓ For complete information, write for bulletin 230-C on the Bailey Pyrotron Electronic Resistance Thermometer. P-27-1



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Complete Controls for Process Plants

BAILEY METERS

Controls for

TEMPERATURE
PRESSURE
GAS ANALYSIS
FLOW LEVEL
RATIO

how to provide
PROTECTION · *PLUS*

for enclosed
gear drives . . .

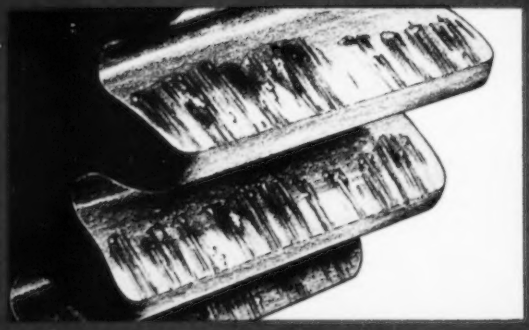
SWITCH TO GULF E.P. LUBRICANTS

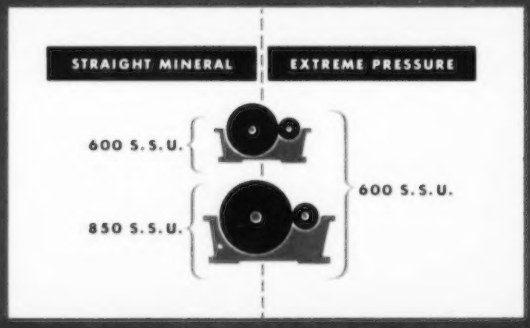
. . . and save maintenance dollars!

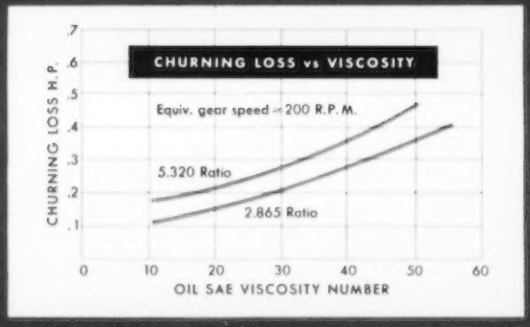
Gulf E. P. Lubricants combine all the properties that count in an extreme pressure lubricant: high film strength, excellent rust preventive properties, good water-separating characteristics, good stability, and they are noncorrosive, nonfoaming. Their use insures longer gear and bearing life and lower maintenance costs for gear drives under a wide range of operating conditions.

Gulf E. P. Lubricants are available in the proper viscosity for every gear requirement ranging from 55 to 1000 SUV at 210 deg. F. For specific recommendations for your equipment, call in a Gulf Sales Engineer today. Write, wire, or phone your nearest Gulf office or send the coupon on the last page.

GULF INDUSTRIAL LUBRICATION







Practical advantages of Gulf E. P. Lubricants:

More effective protection against tooth scoring and welding

Gulf E. P. Lubricants have proven ability to protect gear teeth against damage by scoring and welding. They are specially compounded to provide extra film strength and to prevent metal-to-metal contact under most conditions of overload and shock load. That's why you can usually avoid tooth damage like that shown at the left when you use Gulf E. P. Lubricants. And that's why they provide an extra margin of protection when production demands approach or exceed the rated capacity of the equipment.

Fewer lubricant grades needed—lubricant storage and handling simplified

Because Gulf E. P. Lubricants have superior film strength, it is often feasible to use a lower viscosity grade than would be possible with a straight mineral oil. This is a practical advantage for plants operating several different types of gear drives. If, as pictured at the left, two straight mineral oils of different viscosity are specified, one grade of Gulf E. P. Lubricant may well do the job of both. Thus lubricant storage and handling is simplified, and there is less chance for confusion in the oil house.

Reduced power loss caused by churning in splash-lubricated units—lower power costs

There is another advantage in using a lower viscosity oil in splash-lubricated units where power loss due to churning is appreciable. Since this loss is almost directly related to oil viscosity, the use of lighter Gulf E. P. Lubricants often means reduced heat generation and lower power costs.

The chart at the left shows the effect of viscosity on the churning loss in horsepower of a typical gear unit.

Excellent protection against rust

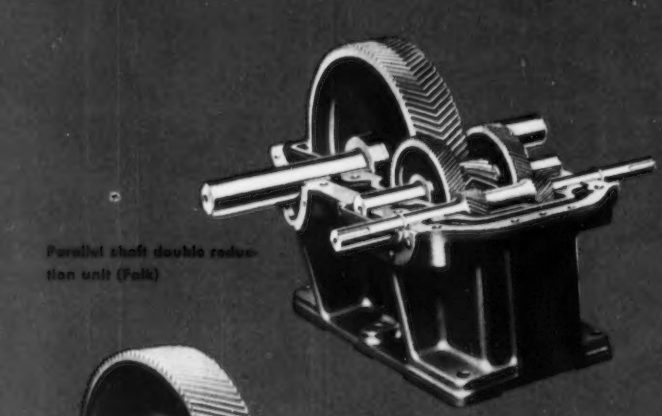
The ability to protect polished gear teeth and antifriction bearings against rust is an important property of a gear lubricant, and is essential in a lubricant for units which are occasionally idle.

Gulf E. P. Lubricants have highly effective rust preventive properties—insure against excessive wear and enlarged tolerances which might result from the presence of abrasive rust particles.

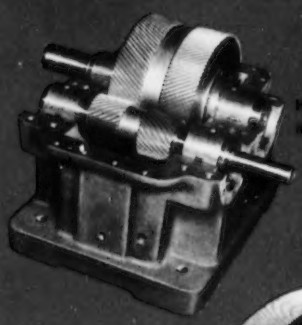
other advantages

- good water-separating characteristics
- non-corrosive
- non-foaming
- stable for this type of lubricant

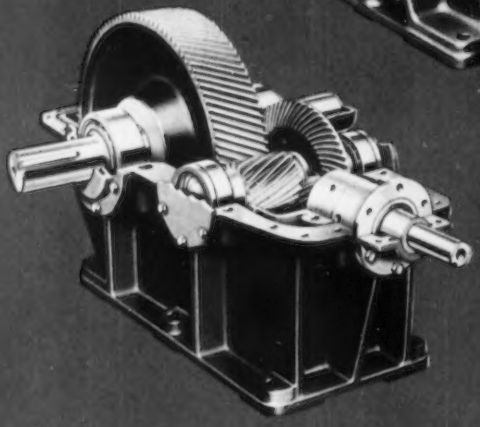
make Gulf E. P. Lubricants ideal for:



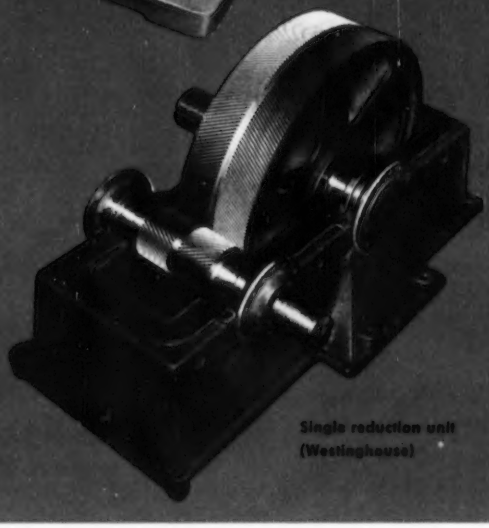
Parallel shaft double reduction unit (Falk)



High speed, single reduction unit (Westinghouse)



Double reduction, right angle drive (Falk)



Single reduction unit (Westinghouse)

GULF OIL CORPORATION • GULF REFINING COMPANY
1822 Gulf Building, Pittsburgh 30, Pa.

Gentlemen:

I would like further information on Gulf E.P. Lubricants:

- ☐ Please have a Gulf Sales Engineer call.
- ☐ Please send me a copy of your pamphlet "Gulf E.P. Lubricants for Reduction Gear Drives."
- ☐ Please arrange to show a group in our plant the new Gulf Color Slide Film, "Gears and Their Lubrication," Part I.

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Company _____

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Give Your Paper Better

WET STRENGTH

DRY TENSILE AND MULLEN STRENGTH

RETENTION OF BEATER ADDITIVES

with RCI

BECKAMINE P-682-35

This urea-formaldehyde, cationic-type resin does more than give desired wet strength to your paper for toweling, bags, butcher and bread wraps, twisting tissues, boxboard liner, etc.

It also increases dry tensile and Mullen strength and helps the paper to retain such beater additives as clay, rosin size and starch.

In fact, when starch is used in tub sizing, BECKAMINE P-682-35 imparts still other advantages . . . aids in laying fuzz, improves scuff-resistance and waterproofs the starch.

Apply this Reichhold resin either at the beater or after the refining operation to bleached and unbleached kraft or sulfite, ground wood, rag or mixtures of these materials.

Get the full facts by writing for Technical Bulletin P-2.

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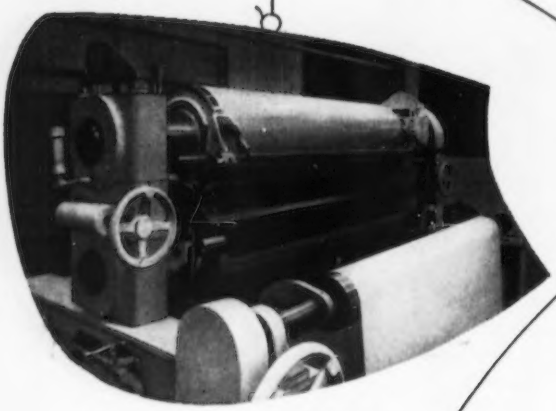
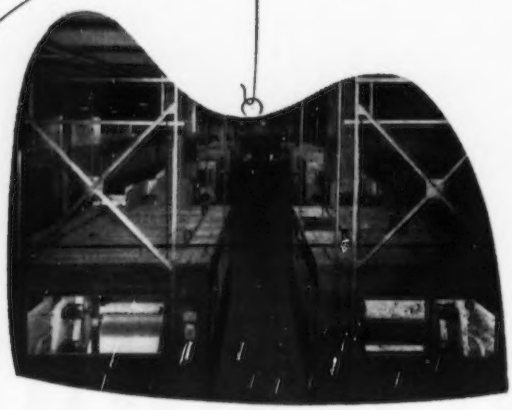


Treater

FOR LAMINATED PLASTICS INDUSTRY

The Formica Company, Cincinnati, O., has installed three Treaters in two of their plants



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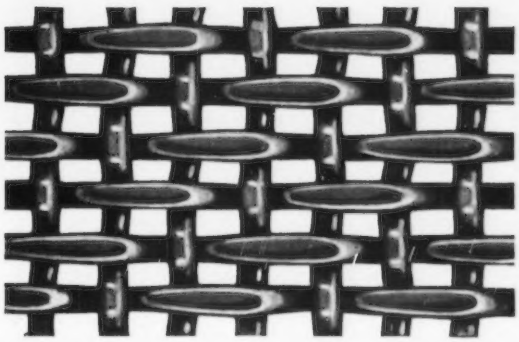
-it always means the best



Whatever the field or line of endeavor, specialization makes for superior results. Always, *since 1903*, Lindsay's entire attention and resources have been devoted to the weaving of Fourdrinier wire cloth for one purpose – *the manufacture of better paper and paper products.*

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FOR REBURNING LIME SLUDGE

The illustration above shows a modern, Smidth Rotary Kiln for reburning lime sludge at the plant of the West Virginia Pulp & Paper Co., Charleston, South Carolina.

F. L. Smidth & Co. are specialists in the design and manufacture of rotary kilns and have furnished numerous installations in many countries for burning lime, lime sludge, dolomite, magnesite, cement, ores, etc.

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G-E LIMITAMP controls the operation of high-voltage motor drives up to 2250 hp . . . gives you quick, silent protection for personnel and equipment against dangerous short-circuit conditions up to 250,000 kva . . . helps prevent costly shutdowns.

Safety for your personnel and equipment with high-voltage G-E Limitamp Control

Don't take chances with dangerous short-circuit conditions. G-E Limitamp Control protects against sudden electrical overloads . . . assures greater safety for your personnel and costly electrical equipment. A high-voltage motor control, G-E Limitamp Control provides interrupting capacity up to 250,000 kva.

MAINTENANCE PERSONNEL is guarded by a steel barrier separating high- and low-voltage compartments. A mechanical door interlock assures motor circuit interruption before the fuse compartment door can be opened.

GET EQUIPMENT PROTECTION with General Electric Type EJ-2 fuses which clear fault current in less than ¼ cycle, operate only under actual "short" conditions. Also, improved heavy-duty air-break contactors give you millions of operations.

FOR YOUR SPECIAL OPERATION individual components need not be specified. Let G-E application engineers select the correct components, give you the right interrupting capacity . . . better personnel and equipment safety.

FOR COMPLETE INFORMATION about G-E Limitamp Control, contact your nearest G-E Apparatus Sales Office, or write to Section 781-7 for Bulletin GEA-5409 today. General Electric Company, Schenectady 5, N. Y.

MAINTENANCE IS EASY . . . Fuses swing forward on hinges for the disconnect position and fuses can be quickly lifted out.

You can put your confidence in—

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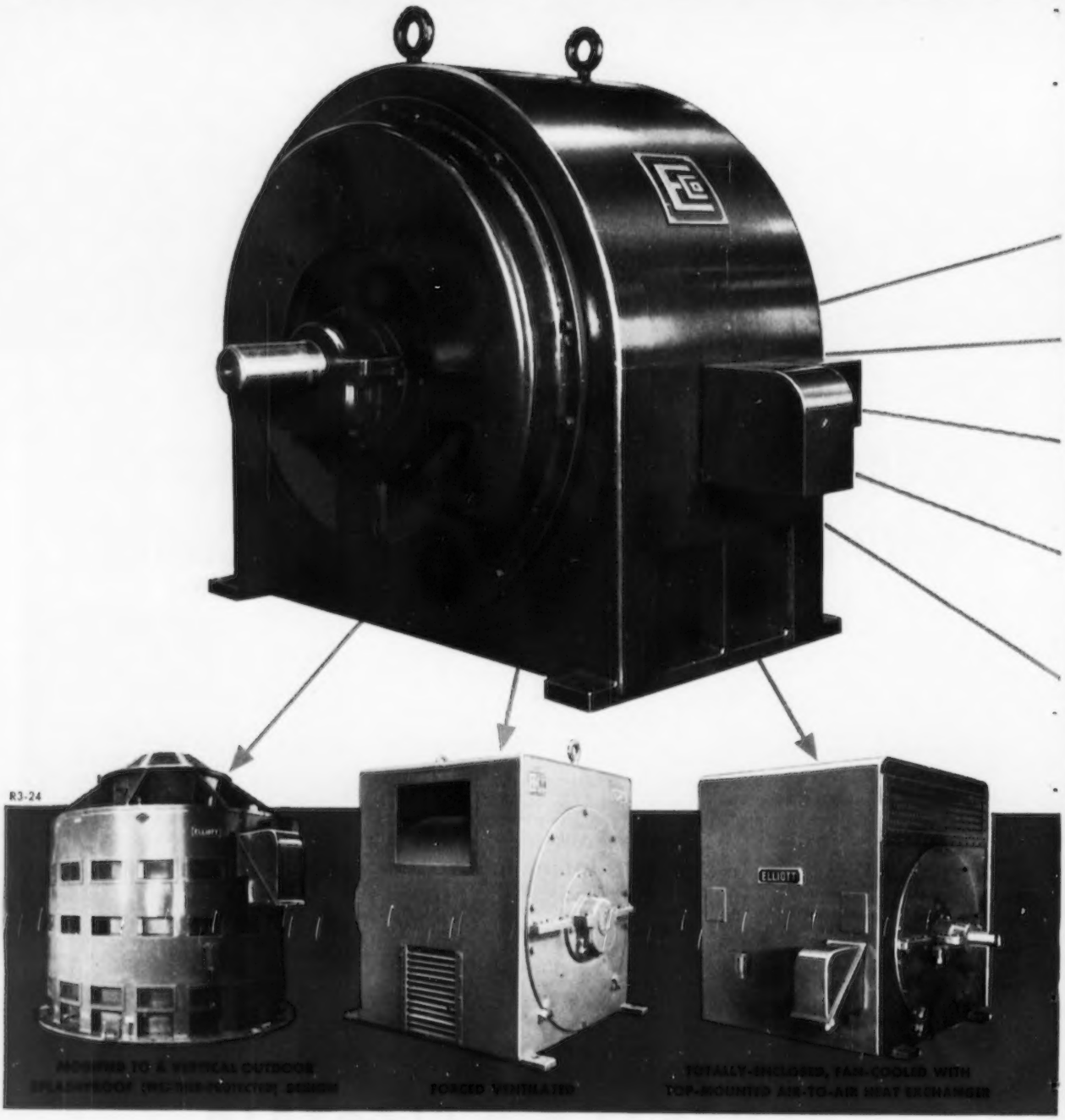
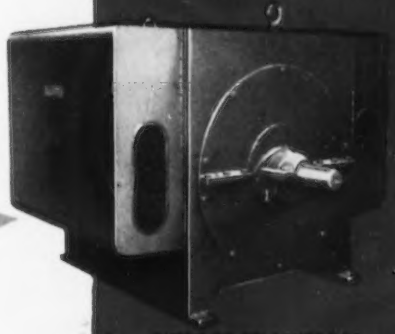
With ELLIOTT "fabri-steel" you take your choice



motor construction of enclosures

Without change in electrical design, an Elliott Fabri-Steel motor can be provided with the enclosure required by the application. To illustrate, here is a standard Elliott drip-proof squirrel-cage induction motor, and below it the wide variety of enclosures, each adapted to special conditions, in which the same motor can be obtained.



The answer is Elliott Fabri-Steel construction—actually tailoring in metal—which combines the crack-proof strength of steel with the extreme rigidity of skillful fabrication. It's the modern way to build large motors, now recognized throughout industry, with a ready adaptability to enclosure variation impracticable by other means.

For full data on Elliott "Fabri-Steel" motors, contact your local Elliott representative or write Elliott Company, Ridgway Division, Ridgway, Pa.

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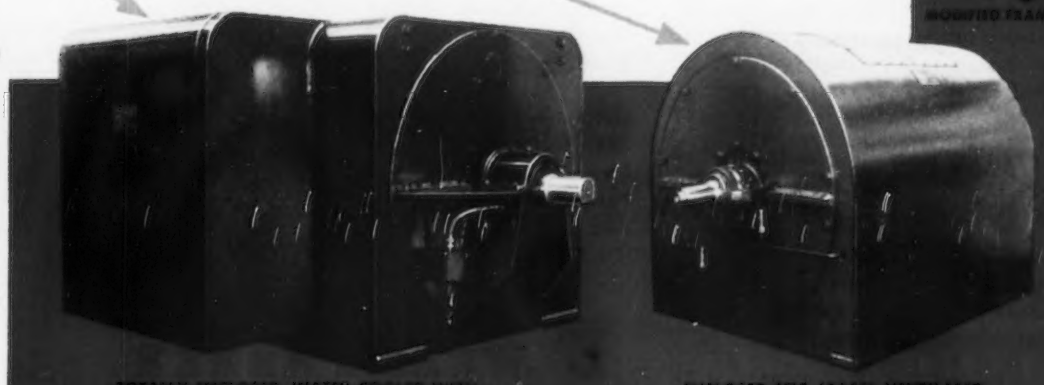
RIDGWAY DIVISION
FOR MOTORS 1-200 HP. CROCKER WHEELER DIV. AMPERE, N. J.

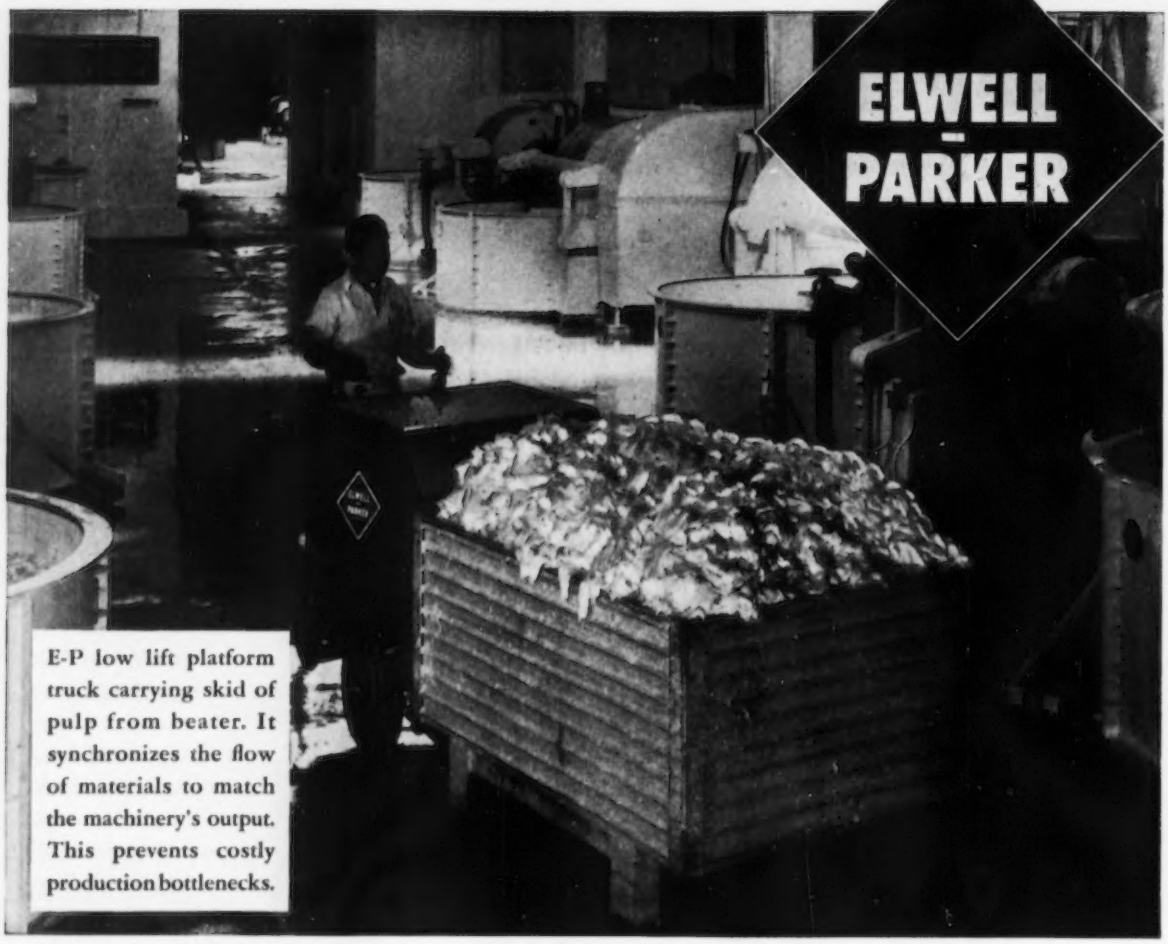


TOTALLY-ENCLOSED, WATER-COOLED WITH SIDE-MOUNTED AIR-TO-WATER HEAT EXCHANGER

ENCLOSED SELF-(BASE) VENTILATED

Elliott FABRI-STEEL

get MORE for your truck dollar from



E-P low lift platform truck carrying skid of pulp from beater. It synchronizes the flow of materials to match the machinery's output. This prevents costly production bottlenecks.

because ELWELL-PARKER—

Furnishes ALL types—Elwell-Parker gives *unbiased* advice since it produces both gas and electric trucks. Basic models include high and low lift platform trucks, fork trucks, mobile cranes, tractors.

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POWER INDUSTRIAL TRUCKS
Established 1893

80 years until harvest time!

Douglas fir forests, which supply raw material for most of Weyerhaeuser's mill sites, require 80 years to grow a seedling into a tree of mature size. Contrary to popular belief, only a small part of the total program of reforestation is accomplished by artificial planting and seeding. The primary reforestation job is the restocking of cut over land as old growth timber is harvested. This is being done by natural reforestation with seed supplied from blocks of trees reserved during logging and left standing to reseed the adjacent cut-over area. Where natural seed sources have failed, artificial reforestation by sowing tree seeds with helicopters or mechanical seeders is used.

As more and more virgin timber stands are logged in the forests under Weyerhaeuser management, the harvested land begins growing new trees. As the supply of mature timber diminishes, it will be replaced by a steadily increasing volume of new growth.

There are good possibilities of increasing the yield from this land through silvaculture research and intensified forestry and harvesting practices. Thus Weyerhaeuser's twin goals are a *sustained* and *increased* yield of cellulose products from its 2,500,000 acres of timber land.

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RECOVERY

at

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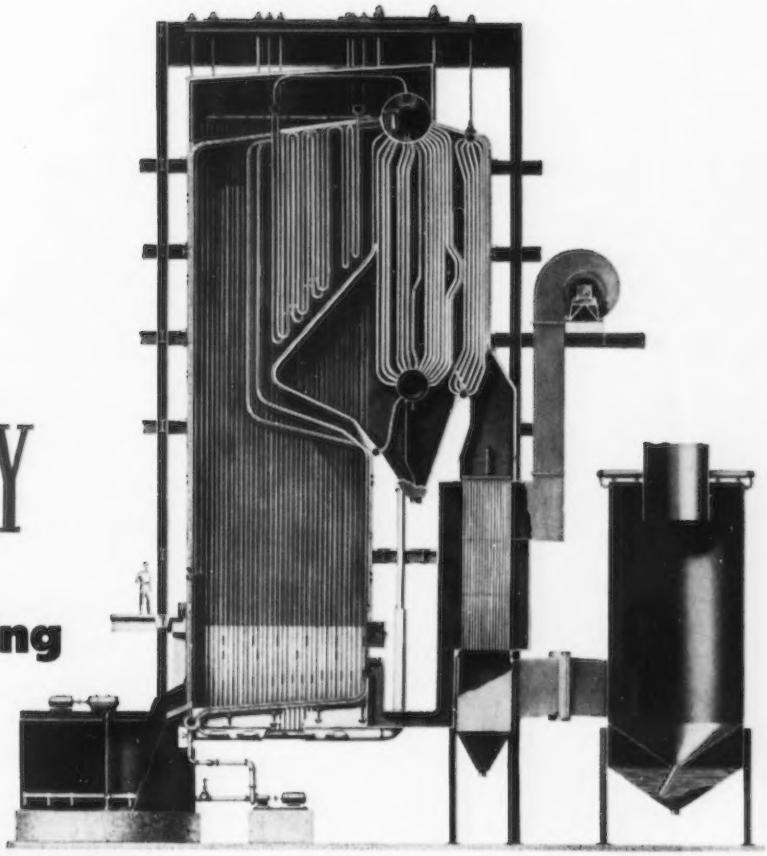

Typical B&W Black Liquor Recovery Unit

Airview of Roaring Spring, Pa., plant of
The D. M. Bare Paper Company

The modernized Kraft mill now under construction at Roaring Spring, Penna., will put The D. M. Bare Paper Company back into pulp production, interrupted since 1951. Chemical and heat recovery will be provided by a modern 83-ton B&W Recovery Unit.

Choice of B&W equipment for this new mill further confirms B&W's ability to design and build efficient recovery boilers for large, medium, or small pulp mills. Foresighted engineering, unexcelled facilities, and many years of experience in meeting unusual requirements, form the base upon which the industry-wide reputation of B&W Recovery Units rests.

The Babcock & Wilcox Co., Boiler Division,
161 East 42nd St., New York 17, N. Y.

BABCOCK & WILCOX

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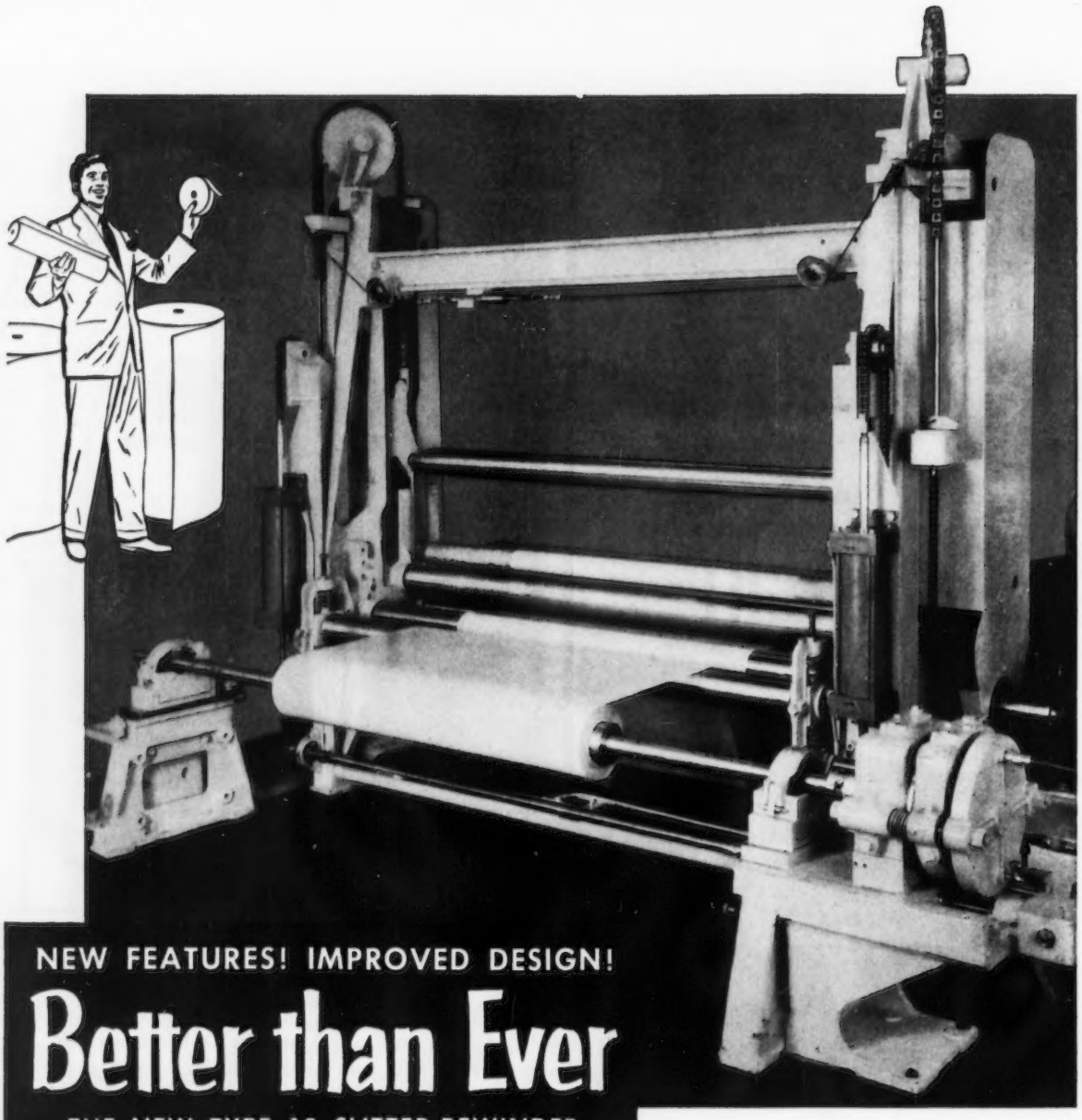

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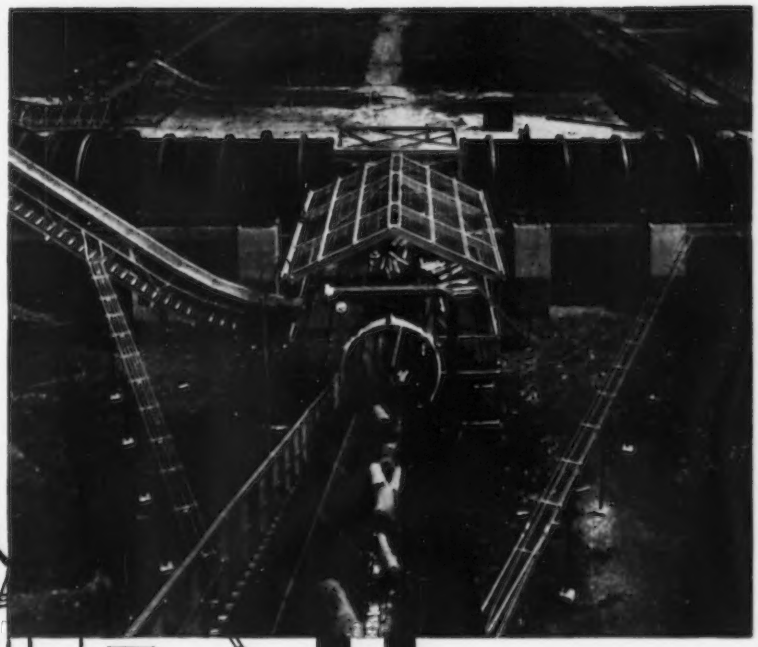

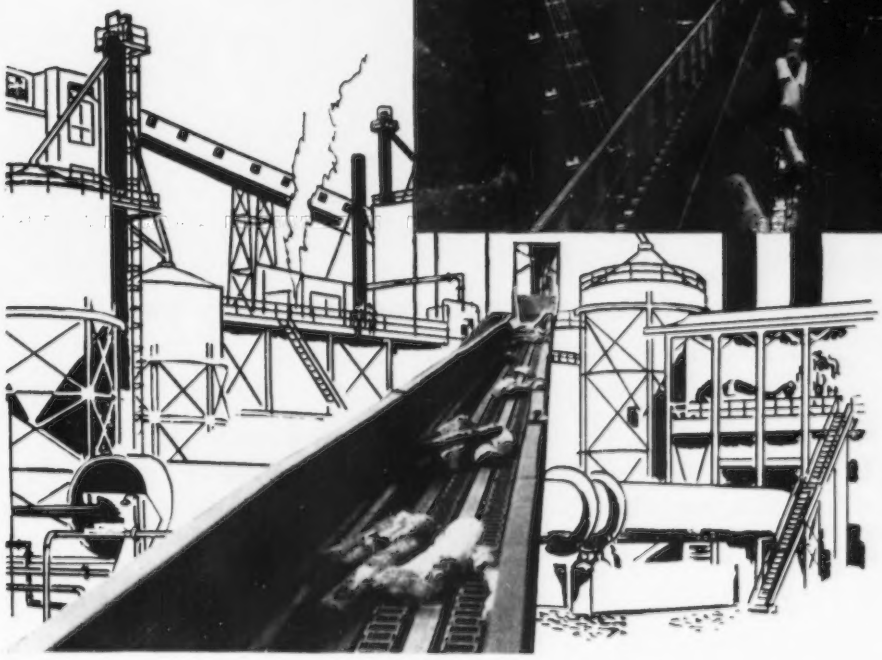

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Field Welding Supervisory Service helps the Foreman to build your Chicago Bridge & Iron Company welded steel tank in accordance with the specifications. Specially selected and trained for the job—there is a Field Welding Supervisor who assists on every welded steel structure we build. He helps make possible the high standards that Chicago Bridge & Iron Company is able to achieve . . .at *no extra cost* to you!

The Field Welding Supervisor is a welding expert and —although independent of the Foreman in charge of a crew—assists him in every way possible to build a structure above and beyond specifications.

Chicago Bridge & Iron Company builds pulp tanks, blow tanks, chip tanks, acid tanks, accumulators, digesters, Marx Savealls, elevated water tanks and other welded steel plate structures for the pulp and paper industry. Write our nearest office for further information, estimates or quotations.

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- **Supervise cutting of plugs and assist in testing and grading the plugs after they are cut.**
- **Help inspect all welding and, if necessary, indicate welds to be removed and re-welded.**
- **Check welding equipment to be sure it is in top operating condition at all times.**
- **Help magnaflux, x-ray, stress-relieve, or conduct any tests called for in the governing specifications.**
- **Instruct and qualify welding operators when additional welders are needed.**

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Mill operators who know quality choose **Bolton Fillings** regardless of the make, type or size Jordans they use. Why **Bolton?** Check the reason:

PATTERNS: Bolton has patterns of all Jordan plugs and shells currently in mill use in Wedgeless, Ring Type or specially designed plugs and Standard or Special Hydro Truss Assembled Shell Fillings. Proper fit is assured.

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for

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In any shape or size you wish — single, duplex or special arrangement, all widths, all designs, for brushing and cutting and all variations in between.

WOODS:
All are supplied with our own selected kiln dried plug woods in oak or maple, South American hard wood or special material separators.

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BOLTON FILLINGS for Beaters and Washers: Beater Roll Fly Bars and Woods — same uniform quality, all sizes, all makes, in Regular Heat-Treated Steel, Alloy Steel, Stainless Steel, Bolton Special Stainless and Phosphor Bronze.

Also, **Bolton Special Stainless** welded to a soft steel backing made by an exclusive Bolton process. This provides long life, acid-resisting stainless steel at the wearing part of the bar and a soft steel backing, which resists shock and prevents ear breakage to a marked degree.

Roll Woods are of selected stock — one, two, three piece or special type uniformly kiln dried.

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LUKENS RIMMING-TYPE STEEL FOR SULPHATE DIGESTERS

In answer to the demand of the paper pulp industry, a modern digester steel similar to the old-type rimming steels but with the properties required by today's fabricating techniques is now available from Lukens Steel Company, a leading producer of rimming steel over many years.

The special rimming-type steel is being offered in answer to requests by pulp producers and equipment fabricators following investigations of steels presently being used in digester service. Already in use in a number of digesters, Lukens rimming-type steel combines the desirable qualities of old-type rimming steel with these modern fabricating advantages:

READILY FABRICATED IN HEAVY PLATE THICKNESSES—Lukens rimming-type steel can be readily fabricated in the heavy thicknesses—around 2 inches—required for digester service. This combination of the qualities of old-type rimming steel with desirable fabrication characteristics is made possible by Lukens' unique steelmaking process.

AVAILABLE IN EXTRA-WIDE PLATE—Lukens rimming-type digester steel is available from Lukens in extra-wide plate sizes—up to 186 inches—and in extra lengths. These larger sizes make possible fewer courses, fewer seams and fewer fabrication operations in the finished vessel. You benefit from less maintenance, less need for repairs.

This modern digester steel is another example of how teamwork between equipment users, process engineers, qualified Equipment Builders and materials suppliers pays off for you in improved equipment. Experienced builders regularly turn to Lukens for its knowledge of materials as well as its wide range of specialty steel plates, heads, and steel plate shapes providing essential design freedom, economy and long life.

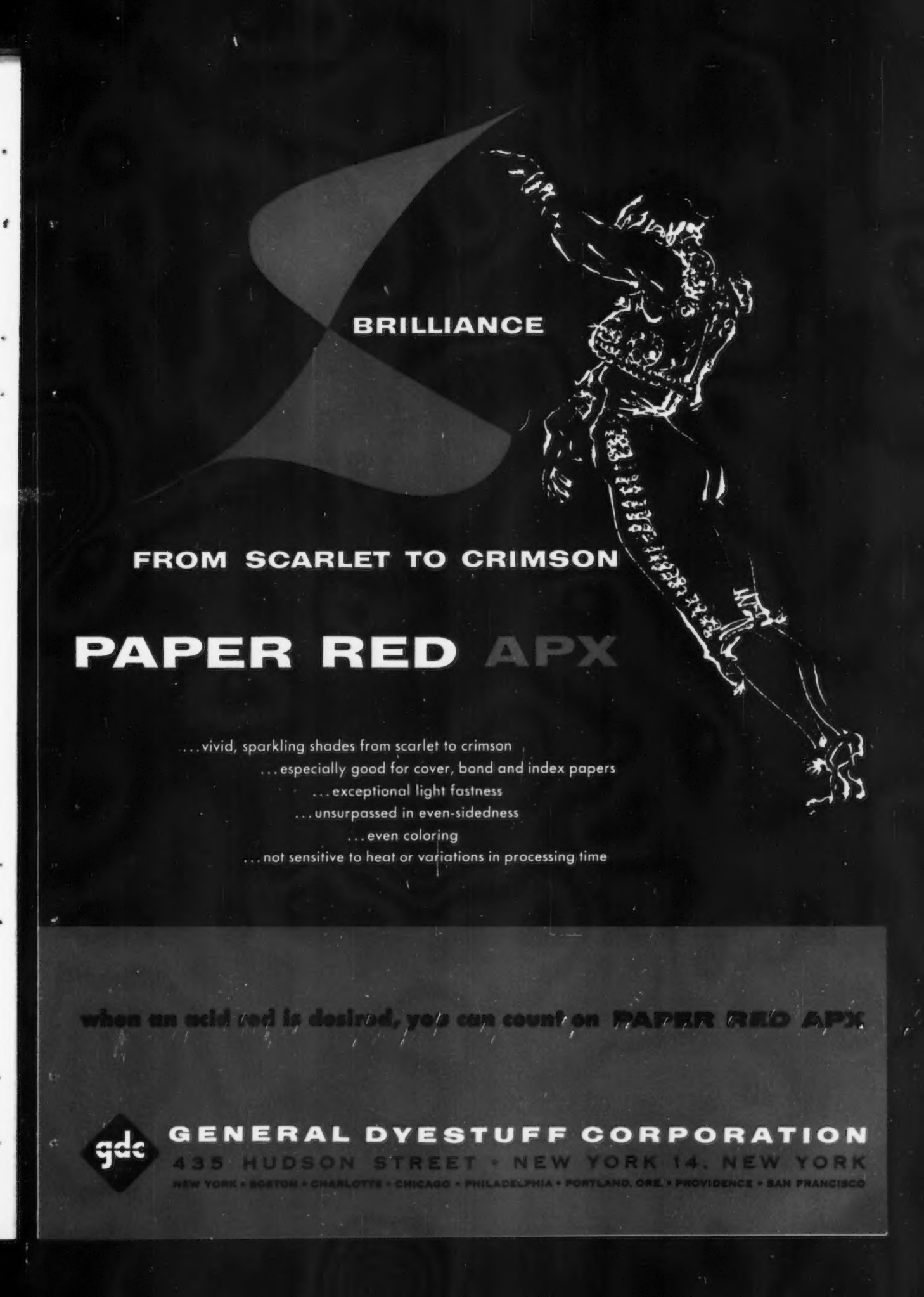
We will welcome the opportunity to discuss Lukens rimming-type digester steel with you further, or give you the names of Equipment Builders versed in handling it. Write us today explaining your needs. Manager, Marketing Service, 403 Lukens Building, Coatesville, Pa.

LUKENS

World's Leading Producer of

SPECIALTY STEEL PLATE · PLATE SHAPES · HEADS · CLAD STEELS

LUKENS STEEL COMPANY, COATESVILLE, PA.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THE FOLLOWING PERFORATED PARTS, IN FINISHED OR SEMI-FINISHED FORM

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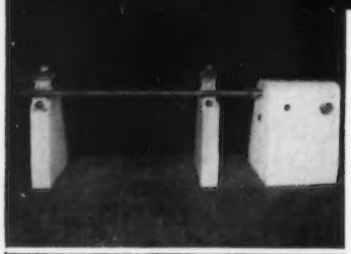
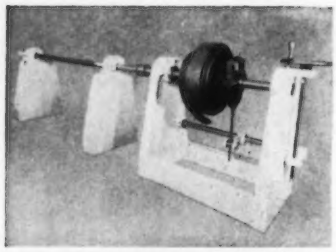
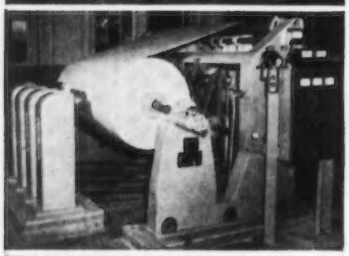
DILTS UNWIND AND WIND *For Every Converting Operation*



Single position unwind with friction brake.

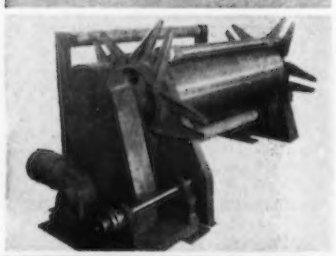
Single position center winder with slip clutch.

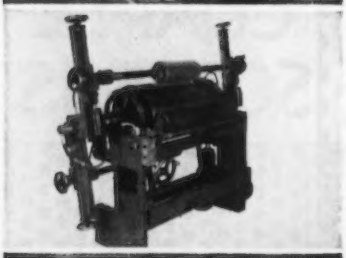




Single position stand with belt constant tension for high speed unwinders.

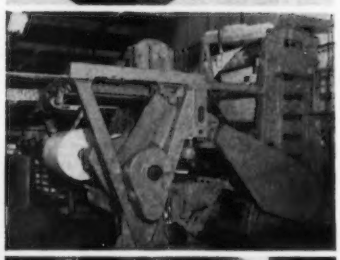
"Ferristart," continuous surface winder for paper and plastic webs.





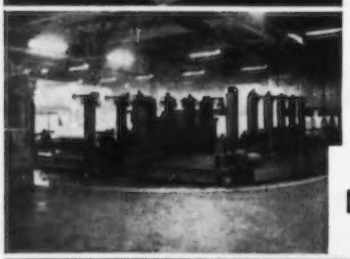
"Ferrisplice" continuous unwind for small diameters and narrow rolls.

Combination reel for unwinding and winding on super calenders.



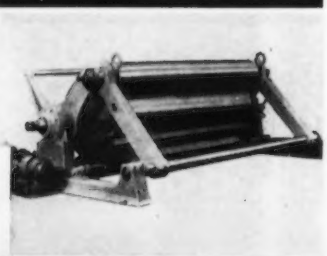
Kohler System continuous unwind for high speed flying splices.

Kohler System continuous winder for high speed flying splices.



Rotable; multiple unwind stand for reducing down time on finishing room cutters.

Black-Clawson uniform speed reel for continuous winding.



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Fulton, New York

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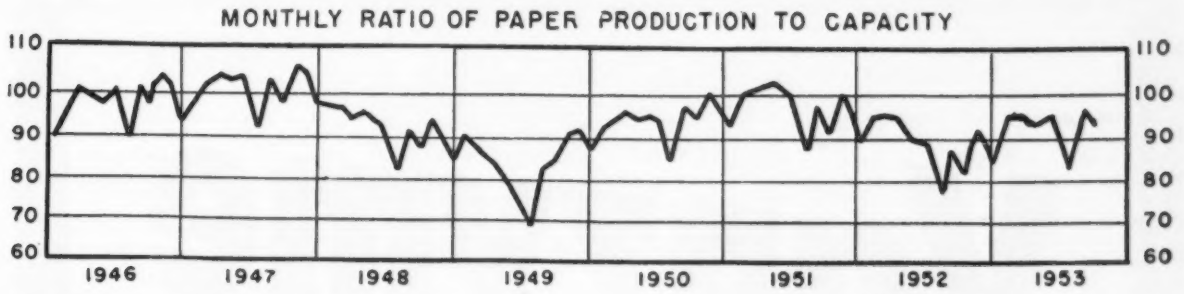
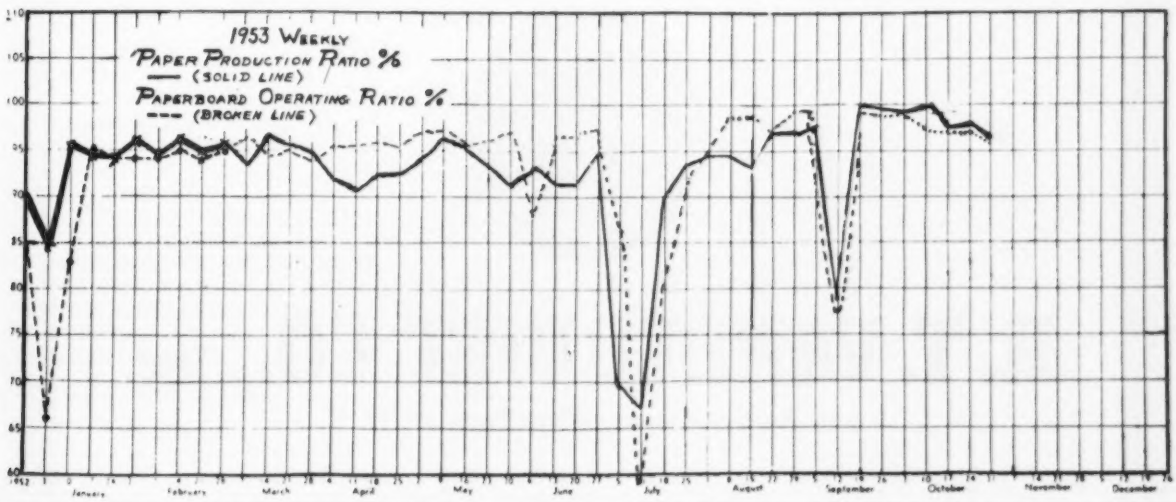


Brief of Important Figures

Source	Production	WEEK ENDING Oct. 31, '53	Oct. 3, '53	Nov. 1, '52
APPA	Paper Production Percent Capacity[3]	96.9	97.2	91.3
NPA	Paperboard Operating Ratio Percent Inch Hours	96	98	97
		Sept. 1953	**Aug. 1953x**	**Sept. 1952**
APPA	Paper Production[3] (Except Newsprint and Building Papers) ....Tons	852,000	868,688	755,000
	New Orders ....Tons	872,000	865,554	804,000
	Unfilled Orders ....Tons	914,795	896,060	805,806
	Shipments ....Tons	852,000	867,729	748,000
		Oct. 1953	**Sept. 1953[2]**	**Oct. 1952**
NPA	Paperboard Production ....Tons	1,040,912	1,242,696	1,222,424
	New Orders ....Tons	892,929	1,383,242	1,255,736
	Unfilled Orders ....Tons	423,728	590,808	452,959
	Our Customers Activities Index[1]	**Latest Mo.°**	**Previous Mo.°**	**Year Ago°**
FRS	Durable Mfg. Index	313	313	269
	Nondurable Mfg. Index	201	192	195
	Printing and Publishing Index	174	161	157
ODC	Magazine Advg.-Printer's Ink Index	382	420	369
	Prices Index			
BLS	Consumers Price Index[4]	115.0	114.7	114.3
	Wholesale all Commodities[4]	110.6	110.9	112.2
	Wholesale Pulp, Paper[4] and Allied Products	116.2	115.8	115.6
	Purchasing Power of Dollar, Consumers Prices[4]	87.0	87.2	87.5
	General Activity Index			
FRS	Mfg. Production-Worker Payroll[4]	151.3	149.0	134.2
	Unemployment Compensation Initial Claims (M)	807	1,036	733



[3] New 6-7 day basis.
[4] New Index 1947-1949=100.
[5] For details see APPA Monthly Statistical Summary—September 1953 Estimated Figures.
° Latest Month Available on Request.
x Revised Figures. N.A.: Not Available.
[2] For Five Weeks.

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TRENDS

PAPER TRADE JOURNAL

U. S. Pulp Market Held In Fine Balance

The halfway mark in the year's final quarter finds the U.S. wood pulp market in fine balance, with prices firm-to-tight and little spot tonnage available.

Industry sources speak of a few domestic lots available for sale; some Canadian offerings, and occasional Scandinavian parcels.

Unbleached Kraft Tight. The market consensus sees unbleached kraft of every origin tight.

One overseas agent reports his country behind on fourth-quarter shipments with none available for the first three months of 1954.

From another source comes word that a U.S. mill was told that only one-half of his long-term reservation of Scandinavian unbleached kraft would be available in 1954. The consumer cancelled the entire reservation.

Bleached Sulphites Well Sold. Domestic and overseas grades of bleached sulphites are well sold.

Canadian grades too are behind in shipments of bleacheds. One mill agent spoke of his firm's embarrassment at not being able to deliver tonnage as fast as the mills ask for it.

Unbleached sulphites are believed to be less strong, and Canadian *news* grades are likely to found among market offerings, though this conclusion wants for confirmation.

For the bleached krafts, all markets are reported sold up.

A Tough Market. To hear pulp men tell it, it's a tough market. They find buyers for pulp when it's priced right. But they can't make any money on the spot market on which they had counted.

The mills say they can't lift the price of their product because of close competition; their labor costs are up, and they want right price for every ton of pulp.

Price Factor Is Root of Market Balance

The root of the fine balance of supply-demand lies in this very price factor.

The domestic mills have a need for certain marginal quantities and special qualities of overseas pulps. But "the elephant which never forgets" is rampant in the U.S. market. Yankee buyers are forever touchy on the subject of Scandinavian pulp prices which are a matter of record for 1951. They want to dicker for price.

The $1 More Is Offered. One is reminded at this point of a remark attributed to a well known Swedish representative here in New York, which follows these lines:

"When the Scandinavians can get $1 per ton more in other markets, they won't be pressing the U.S. market."

That they can now get this premium in other world markets, either through bilateral agreements or in sterling is common knowledge. In the vernacular of luncheon cocktails here, some of them have gone high hat about the U.S. consumer.

Swedes Express Wish To Continue Selling Here

This comment does not check with the opinion of *Swedish Wood Pulp Journal* which is reputed to speak for the major Swedish mills.

Says the writer in September 30 issue:

"It is vain to think that the quotations in the U.S.A. for European cellulose might be raised as much as in other markets. The American and other prices which have been approximately equivalent for some time may therefore again be expected to differ.

"For various reasons, however, the Swedish cellulose industry is anxious not to lose what ground it has gained in the American market. The leading sellers wish to try to continue selling there, even though they might get slightly higher prices elsewhere."

Waste Paper Is Getting Bearish

The complex waste paper market is getting bearish. Lower prices for old corrugated are being mentioned. The hard whites are not quite so strong.

From what was termed a nice supply-balance just a few weeks ago, a soft market condition has been induced by steady collections and lighter mill intake.

Says the ECC. "There seems to be plenty of all grades of wastepaper available in the Eastern markets for all consumers," states the No. 3-45 bulletin of the Eastern Conservation Committee of the Wastepaper Consuming Industries. "And there is no shortage of wastepaper available for collection."

Inventory Gains in October. Eastern wastepaper consumers bought and put away more paperstock during the month of October than in any previous October during the last six years, says Director C. S. Baker of ECC. Inventories of the total grades of wastepaper at the mills were increased 6.6 percent during the month and, on November 2 were 5.8 percent greater than on the corresponding date one year ago. Gains were made in every grade with the greatest in *news* and corrugated.

October First In Purchases. The month of October also ranked first of all previous months of 1953 in weekly average purchases of waste paper. The month was third in consumption. In only 7 of the last 94 months since January 1, 1946 were the average weekly mill receipts greater than during October, 1953, Mr. Baker states.

Industry Sources Report. According to well-informed sources, a few large consumers have temporarily withdrawn from the market in order to bring their stocks into better balance with revised output and dropping backlogs. *Mixed* and old corrugated are particularly hit. Corrugated is somewhat sloppy in supply. *Mixed* is soft.

Mixed Paper Destroyed. Destruction of the mixed paper on the dumps of Brooklyn by organized New York packers—aided by the season's first snowstorm—removed some 1500 tons of this grade from the market and in some measure deferred further weakening of this grade.

As earlier reported, this group of dealers used this method of registering a protest against lower selling prices of mixed paper which became effective October 26.

Kraft Cuts Eased. Double kraft-lined corrugated cuts have been eased by the soft corrugated to a $35/40 level. Maintained at a high level for several months by the short supply of old corrugated, this grade is now more available.

For the chem-fiber lined cuts which are used as secondary kraft pulp, the market is under less pressure but is strong and sold up. November's price to consumers is $47.50 f.o.b. cars shipping point, down $2.50 from October. Product having its origin in the deep South carries a $50 f.o.b. shipping point price.

—E.P.N.

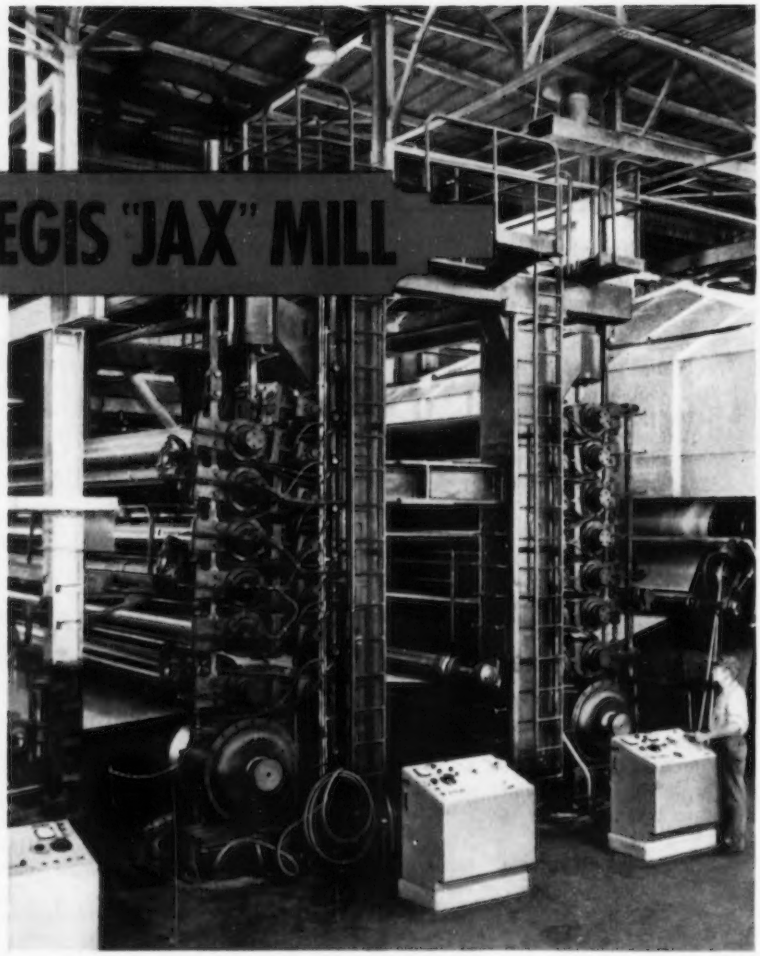
Paperboard Production (Tons)*

	Oct. 31 1953	Oct. 24 1953	Nov. 1 1952	Month of October
Production	257,169	262,973	244,854	1,040,912
New Orders	227,040	213,773	226,485	892,929
Unfilled Orders	423,728	463,706	452,939	423,728
% of Activity	96	97	97	97

* Source: National Paperboard Assn.

New ST. REGIS "JAX" MILL

equips these calenders with



FARREL® ROLLS

The two 220" calender stacks above, installed at the new and modern St. Regis Jacksonville plant, are equipped with "Farreloy" rolls.

"Farreloy" is one type of roll made by Farrel—largest producer of specialty rolls in the world. "Farreloy" rolls are several points harder than regular chilled iron rolls and are designed specifically for those who desire an extra hard roll to start with.

In designing a roll, Farrel engineers are guided by a century of experience in determining the proper combination of metal formula and depth of chill to assure maximum service life. The chilled section is sufficiently hard and deep to resist crushing and abrasion. The structure of the body provides the strength to carry the load on the roll in the service for which it is designed.

For more about Farrel rolls, write for Bulletin No. 116.

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WEEK OF PAPER TRADE JOURNAL NOVEMBER 13, 1953

St. Regis Completes New Bag Research and Development Lab.

The most extensive laboratories in the country devoted to multiwall bag research and development are at Pensacola, Fla.

Extensive new laboratory facilities have recently been completed at the St. Regis Paper Co.'s Kraft Center at Pensacola, Fla. The 60 by 70 foot wing in the Center's new four-story Administration Building provides laboratory and office space for carrying out the St. Regis multiwall bag research and development program. This is conducted in conjunction with the St. Regis Central Technical Laboratory in Deferiet, N. Y.

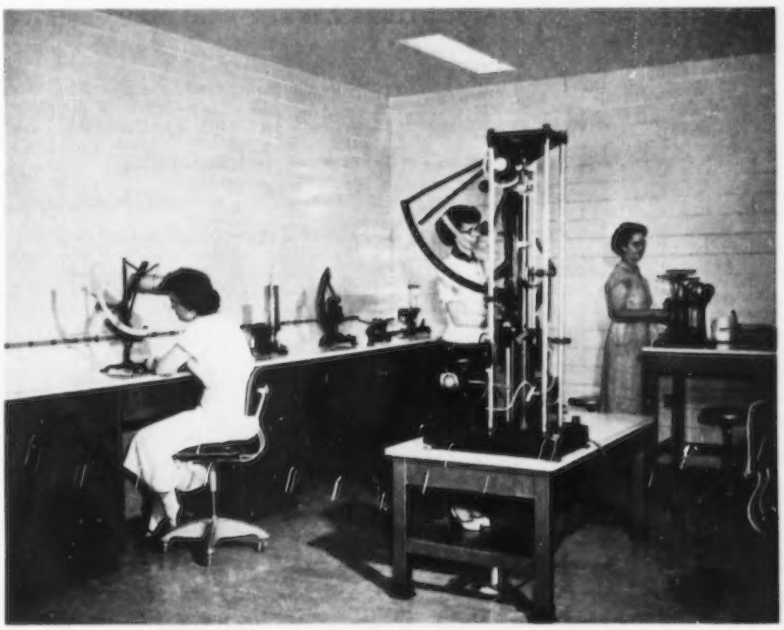
The Kraft Center's laboratory is equipped primarily for evaluation and developmental work on multiwall bags and the conversion materials used in their manufacture, including paper. Many features have been especially designed for the laboratory which contains a broad variety of testing equipment. The new laboratory is made up of a conversion material laboratory, a chemical laboratory, a high humidity room and a bag testing laboratory. A special room contains the mechanical equipment which serves the laboratory facilities.

Conversion materials for all the St. Regis plants in the United States, Canada and Puerto Rico are tested in the conversion materials testing laboratory to protect the plants against possible use of defective materials. Samples from each shipment are subjected to plant trials and tested by the laboratory before the shipment is approved for use in production. A file and graphic analysis are maintained of the paper tests made by each of the St. Regis kraft paper mills. In addition, this department tests outturn samples from all shipments of paper purchased by St. Regis from other companies. The department facilities are available to assist St. Regis' foreign licenses in their multiwall bag research and development.

Paper testing equipment includes basis weight, caliper, mullen, tear, tensile, stretch, porosity, smoothness, stiffness, and folding endurance testers. A new A. van der Korput dynamic tensile tester has recently been added to this equipment. Also available is equipment for testing thread, filter cord, rope and miscellaneous conversion materials and films. Access to other specialized testing facilities is available through the Kraft Center's Paper Mill Laboratory and the Central Technical Laboratory in Deferiet.

A high humidity room, which is maintained at 90 per cent R. H. and 100°F., is designed to accelerate the evaluation of variously constructed bags, films, closures, seams, adhesives, valves, and sleeves as moisture or grease barriers. North and south walls of the 12 by 20 foot room are lined with aluminum racks

Bag testing facilities.



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✓ HYDRAULICALLY CONTROLLED POWER
✓ NO GEAR SHIFTING OR CLUTCHING DELAYS
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From the first name in Mass Handling Equipment comes the last word in torque drives for fork lift truck applications. Here is a product of intensive research and engineering, truly a trouble-free torque converter drive . . . available to match the capacity range of all Towmotor power plants. Here is the one drive that adds still more to superior Towmotor performance. For the complete story in a nutshell, send for book on TowmoTorque now.

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with tracks. These can accommodate 80 aluminum four-wheel 18 by 40 inch carts. Each cart will take one full size bag or a number of test pouches.

The high humidity room and bag test laboratory are especially constructed to permit testing under severe atmospheric conditions.

Bag Test Laboratory

Simultaneous testing of two different sets of bags and materials, one in each end of the 18 by 60 foot room, is possible in the bag test laboratory. A suction grill to the air conditioning equipment is located in each end of the room to prevent intermixing of the materials. An 18 by 30 foot grill-type mezzanine floor which extends over the east end of the room provides storage space and ready access to much of the mechanical equipment and the dust collector. The mezzanine floor is served by a one-half ton monorail hoist and, if necessary, also by a one-fourth ton monorail hoist which normally serves the packers in the west end of the room.

Located along the north wall in the east end of the room is the following St. Regis equipment: elevator, tilt table, and end drop testers as well as a St. Regis 107-FC one tube commercial packer for cement and similar materials. A screw conveyor in this end of the room receives the material from bags broken during testing, moves it to a bucket elevator after which it is passed through a slotted screen and returned to the hopper above the packer.

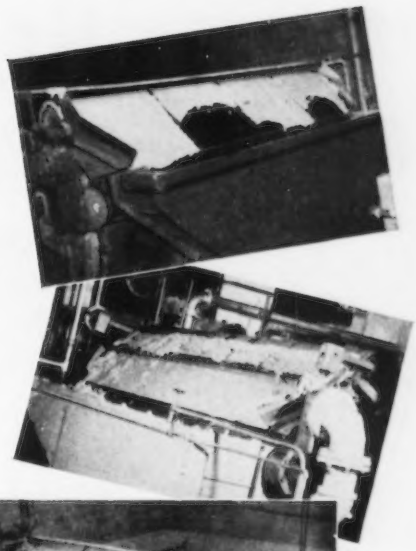
The screw conveyor with the covering grill is closed at floor level by a number of sections of removable steel plates. Any one of these plates may be removed when material is to be dumped from the broken bags. A dust collector with suction at the packer and also at the boot of the screw conveyor controls the dust problem.

In the west end of the room are the following pieces of St. Regis equipment: a portable cement repacker, 100-LS screw packer for flour, sugar, fertilizer and similar materials, a flat drop tester and an end drop tester. Sewing machines for sewn open mouth bags—one for small sugar pockets and the other for large bags—and a wax dipping bath complete the permanent equipment. A St. Regis 100-LF gravity type packer for calcium chloride and corrosive chemicals is being secured.

Atmosphere Control Equipment

The conversion material test laboratory is served by a 7½ ton sealed unit with auxiliary reheat and rehumidification coils. Air for the high humidity room is treated by a humidification and heating located in a room directly above

LOW COST recovery of HIGH COST paper stock



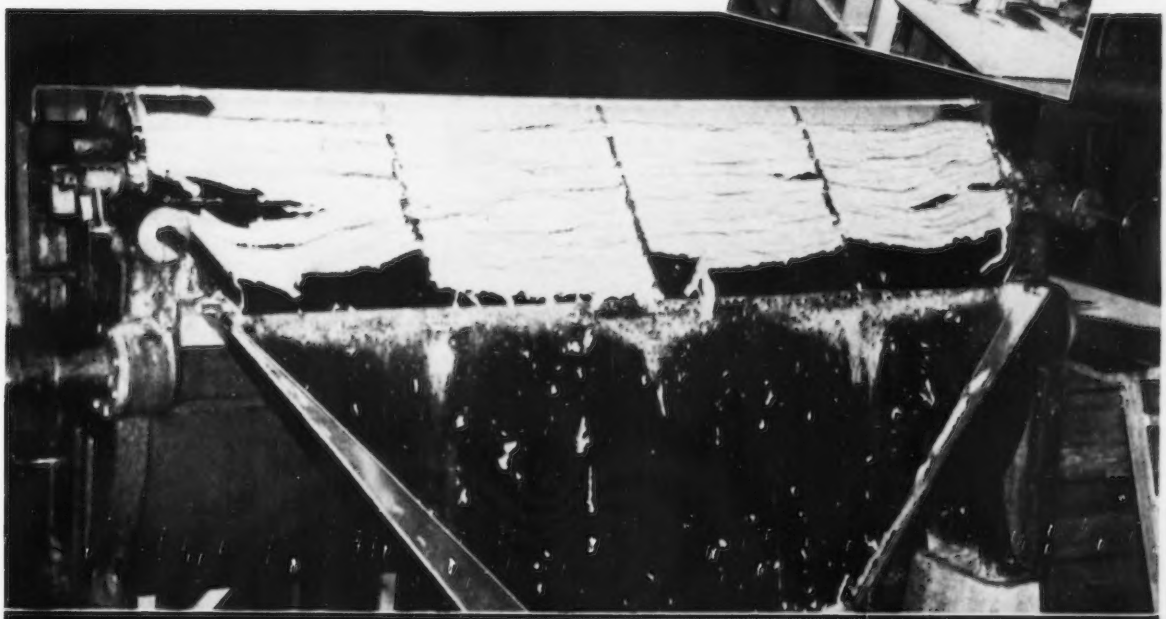
— that's what you're looking at in these pictures of Bird Save-Alls at work.

— and that's what you'd better make sure of in *your* mill

1 by providing enough Save-All capacity to handle your present volume of white water, and

2 by setting up a good, tight up-to-the-minute system that will recover a maximum amount of stock at lowest cost per ton

BIRD SAVE-ALLS



BIRD MACHINE COMPANY

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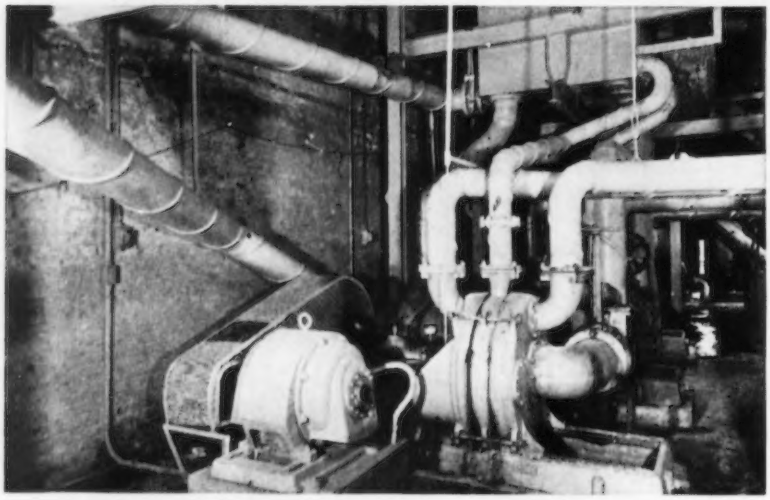
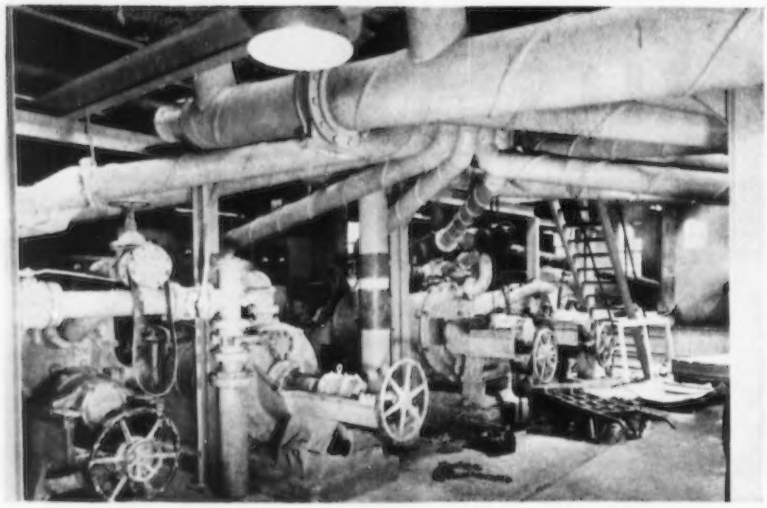
. . . the All-Around Pipe for Paper Mill Service





For lightweight pipe, for fittings and for simple or complicated fabrications, you can count on Naylor to meet your exact specifications. Write for Bulletin No. 507 on line pipe and Bulletin No. 525 for fabricated fittings.

NAYLOR PIPE

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New York Office: 350 Madison Ave., New York 17, N.Y.

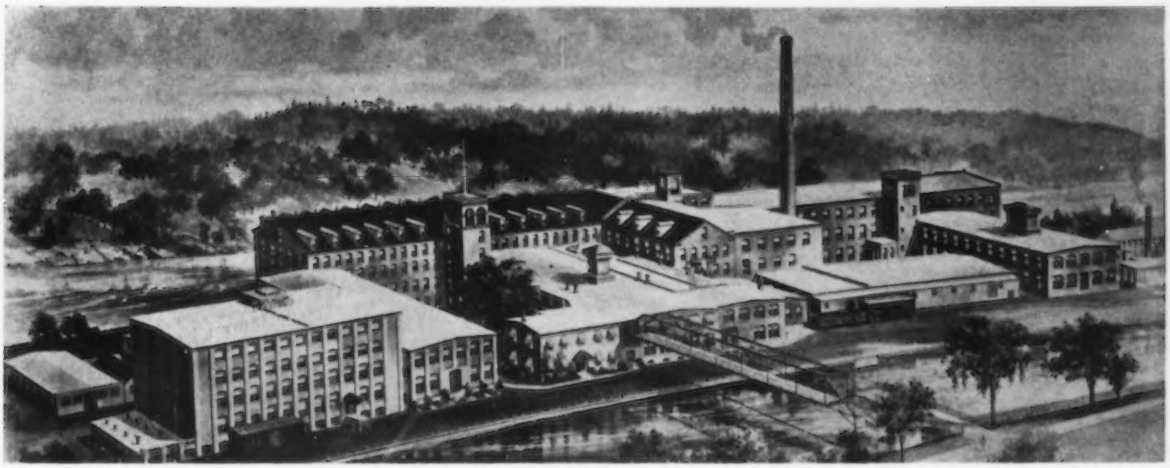
it. This service room is conditioned to 95°F. to provide heated air and prevent rusting and corrosion of the conditioning unit. Conditioned air is admitted to the high humidity room through six louvers spaced around the walls of the room near the floor level and under the aluminum racks. Exhaust air leaves the room through two ducts in the ceiling. All condensation, particularly on the floor, has been eliminated by this reverse flow method.

The bag test laboratory is provided with a very flexible air conditioning system which permits maintaining conditions from 15 per cent to 90 per cent relative humidity and 40°F. to 100°F. The poorer performance of bags at low humidities and temperatures is a seasonal problem in the bag industry. This room was designed to permit the study of bag performance under those conditions. The conditioning system contains the following equipment: a continuous curtain oil bath air cleaner to prevent dust from the room and chemicals in the air from getting onto the conditioning equipment, a dryer, a 50 ton compressor with a 16 bank direct expansion cooling coil, reheat coil, rehumidification element, and 6,000 cfm. fan. The control panel in the bag test laboratory has pneumatic switches which control all of the elements of the system. These switches permit any proportion of the air to be bypassed around the dryer or around the direct expansion cooling coil by separate control.

The 150 pound steam pressure required by the dryer is reduced to 10 p.s.i. by a steam reduction valve. Steam reduction stations are located at the various conditioning units to reduce the 10 p.s.i. steam to the proper pressure for the particular conditions being maintained in the laboratories. Ponds of water on the roofs of the laboratory building reduce the load on the air conditioning units and conserve water. An evaporative cooling tower on the roof of the main building permits reuse of the cooling water for the air conditioning units.

St. Regis research facilities are designed to provide maximum service to the company's customers. The Technical Departments of the St. Regis Printing, Publication and Converting Paper Division, Multiwall Bag and Kraft Paper Divisions were consolidated in 1951 under Dr. K. A. Arnold.

Offices of the Central Technical Department are located in Deferiet, N. Y. The St. Regis Kraft Center's laboratory is directed by Robert P. Anderson.



KEITH PAPER COMPANY

Strathmore Declares Integration of Keith Paper Co. Will Be Gradual

Following purchase of Keith Paper Co., Turners Falls, Mass. (which *Paper Trade JOURNAL* reported last week), Strathmore Paper Co. has announced that it intends to maintain Keith as a separate organization for the time being. However, Strathmore has a program for gradually changing operations at Keith to bring production into harmony with established methods at Strathmore's West Springfield and Woronoco mills.

The Strathmore Paper Co. was started in 1892 by Horace A. Moses as the Mittineague Paper Co. in West Springfield, Mass. The one original paper machine was a fourdrinier. In 1896 a machine for the development of specialties and deckle edge papers was added to the original mill. In 1901 No. 2 Mill at West Springfield was built with the installation of another special machine.

In 1905 the No. 1 Mill at Woronoco, which had previously been known as the Fairfield Paper Co., was acquired with its two fourdrinier machines and operated as the Woronoco Paper Co. until 1911, when it was consolidated with the Mittineague Paper Co. under the name of Strathmore Paper Co. In the following year, work was started on No. 2 Mill in Woronoco, across the river from No. 1 Mill. The new mill was completed and started production in 1913 with the company's largest fourdrinier machine.

Since that time the Company has more than doubled its over-all capacity at the West Springfield and Woronoco mills through constant improvement in equipment and operating methods.

Mr. Moses continued as the head of Strathmore until his death in 1947. He was succeeded by George E. Williamson, who acted as both chairman of the board and president until his death in 1951. At that time C. M. Bryan was elected chairman and F. Nelson Bridgham was elected president.

Keith Paper Co. was founded in 1871 by John Keith, and the original mill was equipped with two paper machines. Two more machines were installed later to take care of the increasing demand for "Keith's Fine Writings."

A man who considerably influenced the company's growth was Albert R. Smith, director, treasurer, and general manager from 1912 until 1937. It was during this period that the mill was completely electrified, modernized, and a new power plant erected, all of which did much to insure quality and service for the product manufactured.

In a re-financing plan in 1938, an agreement was entered into with Deerfield Glassine Company of Monroe Bridge, Massachusetts, whereby the management of that company was given an option on the controlling interest. This option was exercised in 1944.

Through a rehabilitation program during this period production was increased, equipment was rearranged, and much new equipment, including a new air dryer, was installed, all of which made it possible to more than double production in the mill and broaden the range of papers manufactured.

In March 1953 the Company was purchased by Mr. Aaron Krock. Under Mr. Krock plant improvements have been made and the Company's distribution of its papers strengthened.

Hercules to Make Wood Pulp

• Hercules Powder Co., Virginia Cellulose Dept., Hopewell, Va., has received a certificate of necessity for accelerated tax amortization on $7 million with 55 per cent allowed.

It is stated by the Office of Defense Mobilization that Hercules plans to expand production of dissolving wood pulp. Up until now, the Hopewell mill production has been restricted to chemical pulp from cotton linters.

Juneau Mill Pronounced "A Long Range Objective"

A report by Fred Niendorff of the *Seattle Post Intelligence* reveals that the directors of Georgia-Pacific Plywood Co. now view their proposed construction of a $35 million pulp mill in Juneau, Alaska as merely "a long range objective."

It was stated that not only has the company not made financial arrangements but it is far from completing the actual planning of the project.

RESTIGOUCHE

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•

for the manufacture of Cellophane, Rayon and Products of Paper

Restigouche

BLEACHED SULPHITE PULP

RESTIGOUCHE COMPANY, LTD.

Campbellton, N. B., Canada

OPENING SET FOR DECEMBER AT NATIONAL CONTAINER CORP.'s NEW $25 MILLION MILL AT VALDOSTA, GA. Stockpiling of a 90-day supply of pulpwood has begun. The mill will make 500 tons daily of kraft pulp, paper and board, and this output will increase National's total capacity 50 per cent to a daily total of 1500 tons.

Stillwater Paper Mill Producing Under New Owners

The Dica Paper Co. of New York has purchased the Hudson Avenue mill in Stillwater, N. Y., formerly operated by the Saratoga Paper Co., and has begun the manufacture of kraft tissue, with plans for expansion into the toweling and heavy tissue field. The firm employs 20 area men. Frank Fornabio is manager of the company. The factory was formerly operated by the Stevens & Thompson Paper Co., then, in later years, by the Stillwater Paper Co. It has been vacant for about two years.

The mill is equipped with one 72-inch cylinder machine, two beaters, and two jordans.

Westvaco Stockholders Approve H&D Merger

At a special stockholder meeting this week, the merger of West Virginia Pulp & Paper Co. and Hinde & Dauch Paper Co. was voted approval by the West Virginia shareholders. They also approved proposals to split and reclassify the firm's common stock in preparation for an exchange with Hinde & Dauch stock.

The plan by which West Virginia will acquire the Sandusky, Ohio company as a subsidiary is based on an exchange of one and one-third shares of new $5 par value West Virginia common for each share of Hinde & Dauch.

Ontario Mills Reach Agreement with Unions

Four consecutive days of intensive negotiations ended November 6 in settlement of a contract dispute between Ontario's eleven pulp and paper companies and a group of nine unions. Fifteen thousand workers are directly affected.

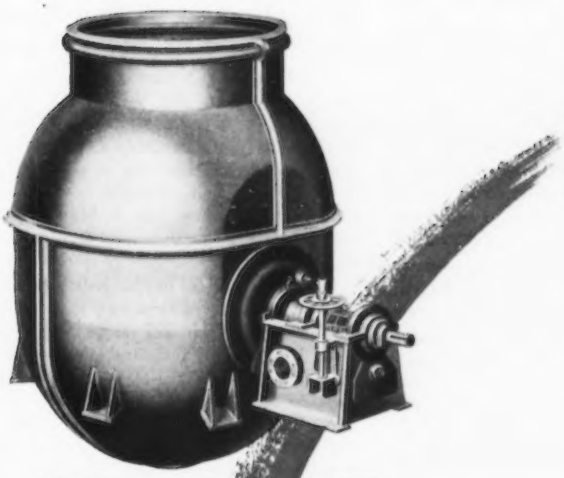
The agreement, valid until May, 1955, keeps unbroken the peace that has reigned in the industry since the strike of 1921.

The terms include a 3 percent increase with a minimum of 5 cents an hour plus improvements in sick leave and overtime rules for shift workers.

Fire Destroys Kelly-Forsyth Power Plant

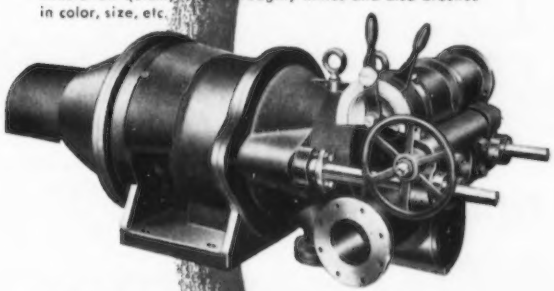
The Kelly-Forsyth Corp., Port Leyden, N. Y., Rock Island power plant was destroyed by fire.

Floyd Dexter, an employe of the mill, discovered the fire in the generator room. The mill employs about 35 men. The loss is partially covered by insurance.



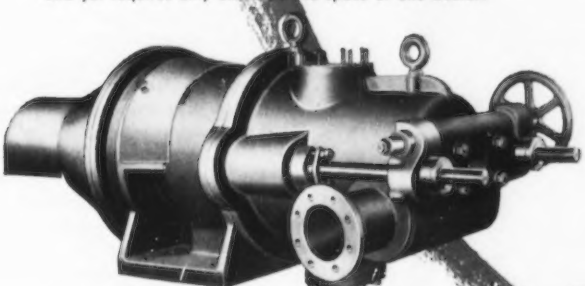
MORDEN "SLUSH-MAKER" FOR PULPING

The "Slush-Maker's" side-mounted rotor quickly and efficiently slushes a full charge of pulp, broke or waste paper, either batch or continuous. The rotor's combination pumping, shredding and brushing blades continually direct the charge at right angles against the attritioning ring, where a controlled bar-to-bar brushing completely clears all flakes and bundles, even high wet strength, without damage to the fibers. The "Slush-Maker's" positive-flow circulation quickly and thoroughly mixes and also brushes in color, size, etc.



MORDEN "STOCK-MAKER" FOR BEATING

The "Stock-Maker" with its 360° bed plate gives the maximum of brushing, fibrillating, beating or hydrating treatment with the minimum of cutting. The "Stock-Maker" operates on a continuous-flow basis from chest to chest or chest to stuff box. The reverse-flow, sealed pressure treatment of one "Stock-Maker" will duplicate or improve upon the stock treatment of two or three conventional beaters and yet requires only one third the space of one beater.



MORDEN "STUFF-MAKER" FOR JORDANING

The "Stuff-Maker" utilizes the "Stock-Maker's" well proven construction features but provides a "jordan-type" flow, for shortening or cutting the stuff when required.

Morden-ize

YOUR STOCK PREPARATION

WITH Morden { SLUSH-MAKERS / STOCK-MAKERS / STUFF-MAKERS

Experience with nearly 700 Morden Machines in 175 mills on all types of pulp and grades of paper proves that:

These three Morden Machines are especially designed, each to excel in one of the three phases of stock preparation—pulping, beating or jordaning.

Each of these Morden Machines is engineered for the utmost in efficiency, simplicity, versatility and economy of operation.

These Morden Machines are designed to fit readily into all types of stock preparation systems and can be used together or in combination with existing equipment to give efficiently the various treatments required for developing the most in each furnish.

Let us know of your interest, and we will gladly provide detailed information on how to advantageously Morden-ize your stock preparation system.

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STOCK PREPARATION EQUIPMENT
MACHINES COMPANY

Corbett Building, Portland, Oregon.

More On Anglo-Can's Saskatchewan Plans

Anglo-Canadian Pulp & Paper Co. has signed an option on a tract of Northern Saskatchewan woodlands, and is investigating the possibilty of building a pulp mill 50 miles northeast of Price Albert as reported in last week's issue.

The 12-month option expires September 30, 1954, and costs the company $10,000 rental for the 2,000 sq. mile area. If the option is taken up, the company must begin construction of a $5 million pulp and paper mill by June 1, 1955.

Initial mill capacity would be 100,000 cords of pulpwood a year. The company also gets first refusal on additional reserves of timberland outside the area.

It is believed that Anglo-Canadian's Saskatchewan investigations are still in the very early stages. Much more work, including extensive engineering and market studies will be needed before a decision can be made. The company has not indicated what type of pulp might be produced.

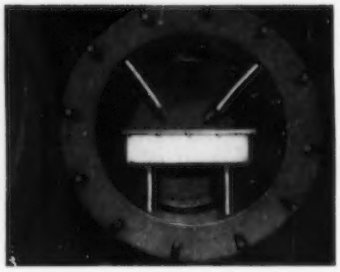
While the Provincial Government, which announced the option agreement, gave no details of Anglo-Canadian plans for Northern Saskatchewan, it is understood that the operation will involve kraft paper production.

DID TRAMP IRON DAMAGE COST YOUR MILL $2227 IN MACHINE BREAKDOWN LAST YEAR?

According to 178 paper mills who replied to the survey conducted by The American Pulp and Paper Mill Superintendents Association and the Eriez Manufacturing Company, tramp iron damage to their paper mill machinery last year was almost $400,000! This is an average of $2227 lost in machinery breakdown and downtime in *each paper mill* . . . of which there are 1071 totalling $2,400,000 tramp iron damage! Damage to pumps and refiners alone was calculated to be $450,000!

NEW VERTICAL DOWN-PRESSURE TRAP PREVENTS DAMAGE TO PUMPS AND REFINERS!

Here's news for all mills plagued with tramp iron damage to pumps and refiners: A *new* vertical down-pressure trap for use in slurry lines has been developed by Eriez!



This new unit consists of a cylindrical housing (furnished by customer) with inlet at top and outlet at bottom. Installed in a section of vertical down-pipe, the trap takes advantage of the force of gravity which draws the flow of material directly onto the middle of the stainless steel magnet. Material then divides in two directions off the sides of the plate into the outlet pipe. Metal impurities fall by gravity and velocity into the intense magnetic field. Depth of flow over the magnet is restricted by baffles to 3½" in depth. A pressure-sealed door on the side can be easily opened to slide the magnet out for removal of collected tramp iron.

Eriez down-pressure traps clean wood chips ahead of digesters before tramp iron can damage wood hogs or valves . . . installed in regulators and head boxes, they stop *all* tramp iron in slurry lines. The traps range in size to accommodate volumes ranging from 1500 gallons per minute to 5000 gallons per minute.

For your FREE copy of survey and analysis of paper manufacturers' tramp iron report . . . for more information on new vertical down-pressure trap, write Eriez today!

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New Machine at Red Rock To Operate by April 1

According to the American Newspaper Publishers Assn., the Wright Co., Inc., sellers of newsprint for St. Lawrence Corp., Ltd., in Canada, are advising their customers that the new machine at Red Rock, Ont., Canada is expected to be in production late in March 1954 and shipments to customers should start by April 1.

St. Lawrence will be the fourth largest pulp and paper producer in Canada after completion of their $22 million improvement program. It includes a new paper machine in their mill at Red Rock and East Angus, Ont.

St. Lawrence will have 13 machines and auxiliary equipment producing approximately 386,000 tons of newsprint annually; 234,000 tons of kraft and capacity for 53,000 tons of surplus market groundwood and sulphite, totaling 673,000 tons of pulp and paper.

The mill at Red Rock will have a daily capacity of 200 tons of newsprint (approximately 60,000 tons annually) and 600 tons daily of kraft paper—container board.

Union Bag Sets Two Records

Union Bag and Paper Corp. plant at Savannah, Ga., has just set two world records in paper production.

On October 31 the plant set an all-time one-day production record of 2,054 tons of kraft paper and paperboard, according to J. R. Lientz, division manager.

Mr. Lientz added that the average daily production of 1,801 tons of paper and paperboard for the month of October represented an all-time monthly production record for the Savannah plant and that this has never been equalled by any other American or foreign mill.

Since the new sixth paper machine was placed on the production line several months ago employes in the woodyard and pulp and paper division have been shooting at a daily 2,000 tonnage mark and on several days during October they missed it only by three or four tons, Mr. Lientz said.

In producing an average of 1,801 tons of finished product daily over a 31-day period, the plant utilized approximately 175 freight carloads of pulpwood each day, and it was necessary that all departments operate with maximum efficiency.

Department heads who, with their assistants and crews, received congratulations from T. T. Dunn, vice-president and resident manager, for the outstanding production are James Piette, superintendent of the pulp mill; C. E. Jackson, superintendent of the paper machine room, and George E. Jackson, superintendent of the woodyard.

National Paperboard Association Reelects Marvin Swaim

- Sees 6.2 Per Cent Production Gain for 1953.
- "How can we keep our industry strong when general business slides a bit?" Swaim offers answers:

The annual meeting of the National Paperboard Assn. convened at the Waldorf-Astoria Hotel, New York, November 5 and 6 and reelected Marvin W. Swaim for his third term as president of the group. Mr. Swaim is first vice-president of Alton Boxboard Co., Alton, Ill.

Also reelected were the two vice-presidents, Ralph A. Powers, president of Robertson Paper Box Co., Montville, Conn., and T. N. Bland, president Fibreboard Products, Inc., San Francisco, Calif.; Albert W. Luhrs was renamed executive manager of the association and Harry S. Adler was reappointed secretary.

Representing mills throughout the nation, the attending members were "fairly optimistic" for a continuing excellent demand for paperboard, Mr. Swaim told *Paper Trade JOURNAL*. The meeting heard reports that paperboard production to date is well ahead of that for any past year, and that total 1953 production is being estimated at some 12,600,000 tons. If this figure is realized, production this year will be 6.2 percent above 1951's record, and set an all-time high for any year's output.

President's Message

"Up to now, our industry has always looked beyond immediate demand," Mr. Swaim told the opening membership session on November 5. He went on to emphasize the long-range approach for several reasons: "First, there is unusual concern today about the immediate future of the nation's economy. Second, for paperboard management, the long-range approach has special importance because of the unique nature of our industry.

"In what ways are we unique—how do we differ from other industries? Well, for one thing, our invested capital—and nearly all of that is frozen—is higher than almost any other industry in proportion to our sales and the number of persons we employ.

"Second, with all our investment, we sell a product which the customers of our customers must give away.

"Third, we make a product that not only must perform its packaging function but also must sell the product that someone else puts in it.

"Fourth, every paperboard product is competing with products of numerous other industries—for example, plastics, textiles, glass, wood and many metals.

IF IT'S A STARCH PROBLEM

Put It Up To...

Let Our Paper Department Experts Give You Valuable Aid On.....

1. TUB AND COATING STARCHES
2. TAPIOCA FLOURS
3. CONVERTED POTATO STARCHES
4. LAMINATING ADHESIVES
5. MANNOGAL (Mannan-Galactan) PRODUCTS
6. GUM KARAYA AND OTHER NATURAL GUMS
7. AMIZYME (the better starch converting enzyme)

Morningstar's modern laboratory and manufacturing facilities are now giving far more effective aid to the Paper Industry.. Our Natural Gum Department (formerly Innis Speiden) is coordinated with the Paper Department in this field. Ask for suggestions, ideas, samples and cost estimates on your needs. Get all the advantages which only MNI's extensive experience and facilities can give.

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Morningstar Scientific Starch, Dextrine and Natural Gum Service is available through all sales and service offices of Paisley Products, Inc., Division of Morningstar, Nicol, Inc., which are located in principal cities.

"Finally, we cannot change direction as rapidly or as completely as many manufacturers. The minute that we set up shop to manufacture paperboard, we can no longer turn back. Like the steel and aluminum, industries, our capital equipment is non-salable. It cannot be converted into cash or modified for the manufacture of anything else. . . . We have kept running by creating our own sales insurance—new uses for our product. . . One economist figures that since 1929 we have grown an average of three percent each year as the result of increased demand for non-durables. New uses, he says, have accounted for an average annual growth of only one and a quarter percent. You can see that we have just scratched the surface in our search for new uses for our product.

RE-ELECTED OFFICERS — R. A. Powers, Vice-President; M. W. Swaim, President; T. N. Bland, Vice-President.

"How about competition from other industries? This, too, we have met by looking beyond our noses; by continuously improving the quality of our product. We have stepped up the *ability* of paperboard to protect, advertise and merchandise the products of our customers, thus simplifying their problems of storage, handling, transportation and distribution. All of this has been done for our customers at a reduced cost to them. . .

"But even though we have established an upward trend during the past 25-year period, the course of our production has been somewhat erratic. We have bounced up and down between the trend lines. It seems to me that our long-range job is to chart for ourselves a production line that climbs more smoothly. We want to eliminate the peaks and the dips. We want to narrow the trend without changing its upward course. I believe the solution lies in long-range thinking, long-range planning, long-range action.

"First, we must take the long view when we are figuring demand for our product. It would seem that the best way to avoid famine is to resist the temptation to consume everything in a feast. We invite trouble when we climb faster than the economy. . .

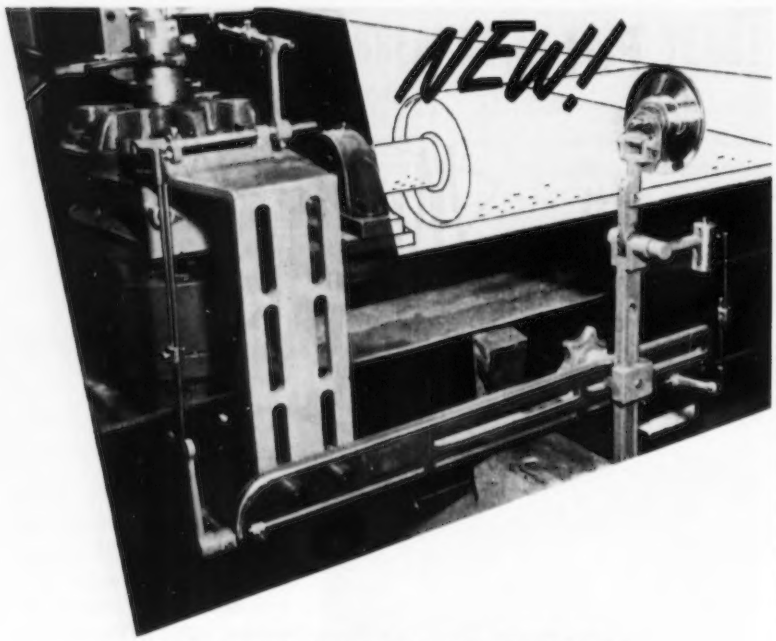
"Second, it is our responsibility to ease the declines that result when the whole economy hits a slump. These declines will occur even if we do avert the sharp drops that result from our own over-expansion. Some economists figure there's a general decline just ahead. Our job is to see that we drop less than the rest of the economy so that we won't have too much ground to regain. How are we to do this? How are we to keep our industry strong and healthy when business in general slides a bit?

"I have no cure-all. Both the sharp drop and the gradual decline are parts of one problem. We must overcome both if we are to take the kinks out of our trend line and keep it moving smoothly upward. I have already indicated that sharp drops can be eliminated if our expansion is geared to the long term rather than the temporary upward surge. Four additional courses offer us a way to cushion the more gentle dips. They all call for the long view.

"For one thing, we must remember that our industry was built by salesmen as well as production men. . . We may have to relearn this old ability to sell. Let's not let it become a lost art.

"Second, there must be unrelenting emphasis on research and development. These give our salesmen the ammunition with which to extend the services of paperboard. Every time we increase total paperboard consumption one percent by discovering new uses, our mills get orders for an additional 125,000 tons of board. It has been estimated that new uses enable us to grow an average of one and a quarter percent each year. Perhaps an intensified long-range program will enable us to double or triple that figure.

"Third, let's clarify, for the benefit of



The GILBERT & NASH

Rotary Palm Blade for Wire Service*

New Rotary Palm Blade for wire service is engineered to travel true *without wobbling or shimmying.* This basic improvement extends life of the blade, prolongs life of wire edge. Unit features SKF 6201Z sealed bearing and is adaptable to present palm assemblies. Write our representative for more facts today . . . you'll find it a rewarding experience.

*patent applied for

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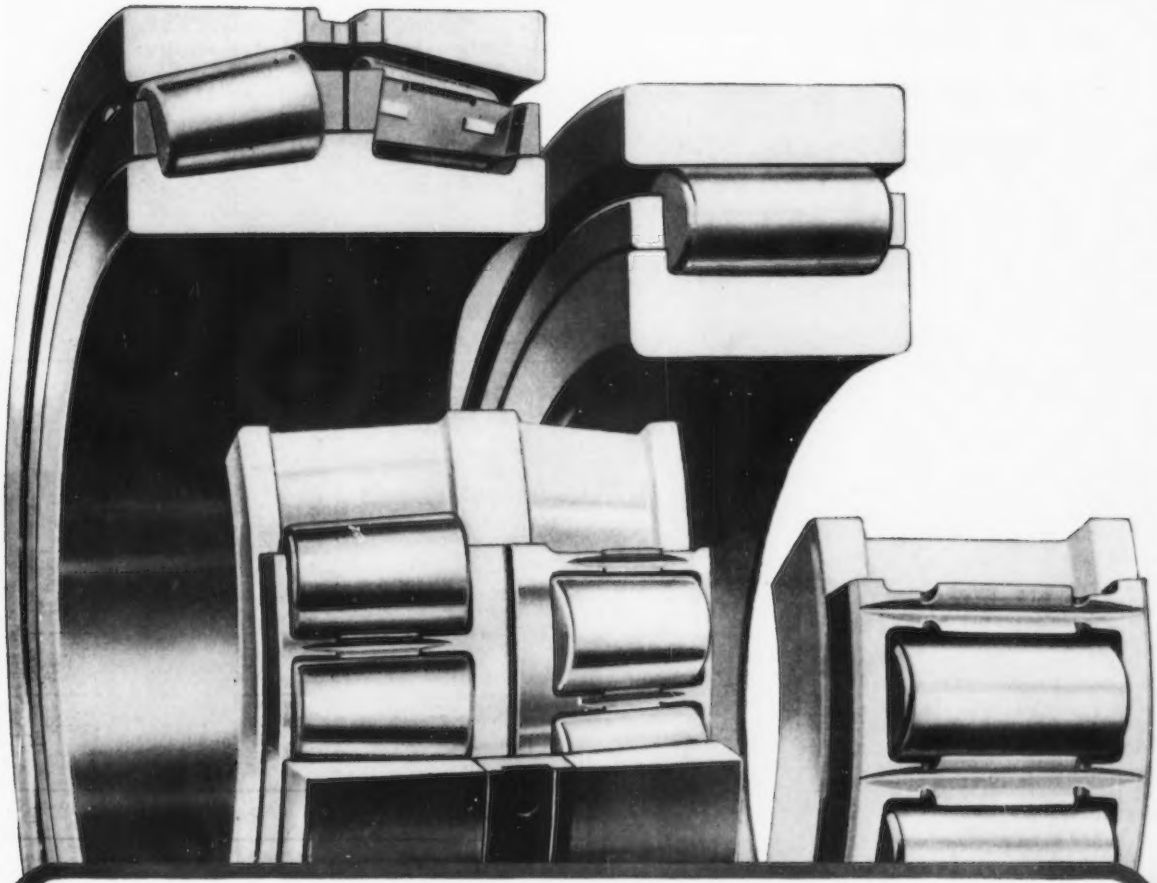

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TAPERED and CYLINDRICAL ROLLER BEARINGS

Give you these BIG ADVANTAGES

- **One-piece cast-bronze cages with machined pads in each roller pocket**—to assure accurate guiding of rollers.
- **Stabilized races**—to maintain accuracy of fit, improve bearing performance.
- **Individual roller retainment**—to assure adequate lubrication at roller, simplify inspection of race surfaces.
- **Precision tolerances and finishes on both rollers and races**—for minimum eccentricity and equal load distribution.
- **Controlled quality steels**—by use of electric furnace steels, through-hardening or case-hardening grades, and modern heat-treating methods—for increased bearing capacity and longer life.
- **Interchangeability**—in all types and sizes.

Backed by custom engineering to meet your load and speed requirements, these advantages add up to maximum performance for your bearing dollar. That's why it always pays to specify TORRINGTON!

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HOW TO ELIMINATE STOCK CONTROL HEADACHES

Today costly stock control problems can be eliminated, and better finished paper obtained quickly, easily and economically, by installing a Poirier Dual Control.

The Poirier Dual Control, with its 4 separate and distinct controlling actions, regulates both stock volume and stock consistency, up to 400 tons per 24 hours. Not only is consistency controlled to within (±) 1/10 of 1%, basis weight (±) 2%, but it is proved under test that volume is also regulated, even when stock becomes too light to be controlled by consistency.

Among the many other advantages of the Poirier Dual Control are homogeneous stock conditions, controlled stock chest (all stock in chest is used), more uniform machine conditions, and a substantial saving in labor. Also, the Dual Control has only one simple adjustment and can be operated by remote control.

Operation of the Poirier Dual Control is not dependent upon stock samples, remote arrangements, or is it subject to inaccuracies from outside variables. By a series of restrictors, gates, etc. consistency is automatically controlled by increasing or decreasing water dilution. Volume is automatically controlled by regulation of the hydrostatic Head. When stock becomes either dilute or heavy, and consistency cannot be controlled by water, the exit orifice is automatically increased or decreased to maintain proper basis weight—as stock goes on wire. With most controls this is usually impossible. The Poirier Dual Control, also assures you of homogeneous stock by eliminating stagnation, settling and water film.

It will pay you dividends as it has so many other pulp and paper manufacturers, to find out how a Poirier Dual Control will help you. Without obligation on your part, one of our engineers will study your operation and furnish you with complete recommendations on how you can eliminate stock control headaches.

Write for full information today.

POIRIER CONTROL COMPANY

Waterville 1, Maine

Specialists in Stock Control Equipment

all concerned, the relationship between management and employes. Over the long term, neither management nor labor can prosper unless both produce. Production can be achieved only by joint effort. . .

"And last, let's retain the youth and vigor of our industry by looking ahead. I have reviewed our past simply to remind you that we have grown by looking at the long-range future. We must continue to look ahead if we don't want to revert to the days of feast and famine. Economists see a rosy future for our industry. We as management, are charged with the job of making such forecasts come true. We control our own destiny."

NEWS OF ASSOCIATIONS

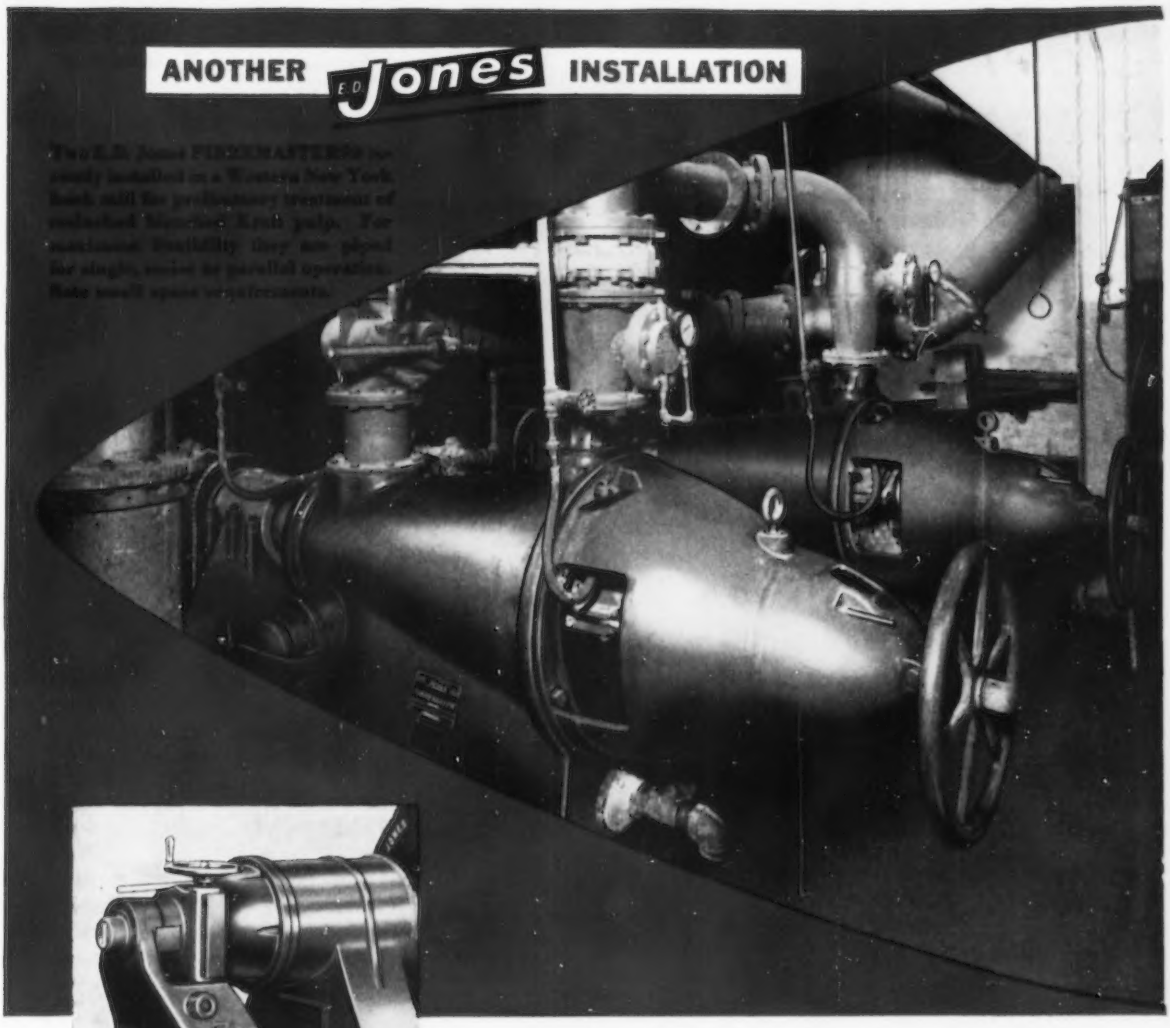
Superintendents Meeting Dates

DATE	DIVISION	PLACE
December 4-5	Pacific Coast	New Washington Hotel, Seattle, Washington
Jan. 15	Connecticut Valley	Roger Smith Hotel Holyoke, Mass.
Jan. 26	Miami Valley Div.	American Legion Hall, Middletown, Ohio
June 21-25	National Meeting	Sheraton-Mount Royal Hotel Montreal, Que.

TAPPI Meeting Dates

DATE	SECTION	PLACE
Nov. 18-20	Alkaline Pulping Conference	Rice Hotel, Houston Texas
Nov. 19	Pacific	Tacoma, Wash.
Dec. 3	Kalamazoo Valley	Hotel Harris, Kalamazoo, Mich.
Dec. 4	Delaware Valley	Riegelridge, Riegel Paper Corp. Riegelsville, N. J.
Dec. 4	New England	Roger Smith Hotel Holyoke, Mass.
Dec. 4	Southeastern	Fort Sumter Hotel, Charleston, S. C.
Dec. 8	Ohio	American Legion Hall, Middletown, Ohio
Dec. 10	Empire State Northern District	La Martina's Restaurant, Watertown, N. Y.
Dec. 17	Eastern District Empire State	Glens Falls, N. Y.
Dec. 21	Chicago	29 So. La Salle St., Chicago, Ill.

ANOTHER E.D. Jones INSTALLATION



Now available with ACCRU-SET® — automatic plug adjustment

This latest triumph of Jones engineering provides completely automatic, completely reliable finger-tip control of plug adjustment for uniform, predetermined power throughout your stock run. Guarantees more uniform stock treatment, less operating horsepower, protection for plug and shell bars if power or stock flow fails.

Easily installed on any Jones Jordan, Fibremaster or Refiner. Write today for details.

MINIMUM Floor Space MAXIMUM Results

The simplified, rugged design of the FIBREMASTER requires relatively little floor space. Yet it has *twice* the capacity of the famous Jones High-Speed Refiner . . . and without sacrificing any of the features that have made the smaller machine so popular.

As a general utility unit on all stocks from news to rag, the Fibremaster combines flexibility, improved stock control, economy of power and low maintenance cost. Ask your Jones representative for details or write for Bulletin *EDJ-1035.*

E.D. Jones

E. D. Jones & Sons Company
Pittsfield, Mass.

BUILDERS OF QUALITY STOCK PREPARATION MACHINERY

SEVEN official Institutes and more than SEVENTY Research Laboratories of big pulp- and papermills and converters are already using the new

STATIC—and DYNAMIC TENSILE-STRENGTH-TESTER

A. van der KORPUT, BAARN (Holland)

Manufacturers of Paper Testing Instruments.

ANSWERS TO 4 Questions

ASKED MOST BY MANAGEMENT

. . . . about rotary spot cutters!

1 **Why should we install a Rotary Spot Cutter?** Because Rotary Spot Cutting is the accepted modern method of obtaining the utmost in production where a web of pre-printed material is to be cut to a register mark.

2 **How about speed?** The speed of the cutter depends on the sheet length. Smith and Winchester's new Rotary Spot Cutter will make from 50 to 400 cuts per minute with a maximum paper speed of 600 feet per minute.

3 **To what degree of accuracy will the machine cut?** With electronic attachments, Smith and Winchester's new Rotary Spot Cutter will split a pencil line up to 400 times a minute with guaranteed accuracy of ± 1/64 inch.

4 **Are standard sizes available?** Yes, including layboy and stacker if desired. Also special sizes can be supplied to meet requirements. Write for complete information.

The Smith & Winchester Mfg. Co.

SOUTH WINDHAM, CONNECTICUT

PAPER BAG AND PAPER MILL MACHINERY SINCE 1828

Live-Steam Drying Process Explained to Kalamazoo TAPPI

A new concept of paper drying was explained to members of the Kalamazoo Valley Section, TAPPI, at a dinner meeting November 5 at Hotel Harris, Kalamazoo. In a paper presented by J. R. Gillis, engineer, Martinson Machine Co., Mr. Gillis revealed that a method of drying developed by him would eliminate the use of metal cylinders now commonly used for drying paper and would speed the process of driving out moisture from webs of wet paper as it comes off the Fourdrinier machines. His plan involves impining live steam heated to 100 degrees on the wet web of paper to achieve almost instantaneous drying. To prevent damage to the paper, the temperature must be lowered when it approaches the dry point. This is achieved by running it through to a second section which contains recirculated steam at a lower heat point.

After drying, the paper is taken out of the section, calendered and finished. Gillis declared that the drying system could be installed at one-third the cost of the systems now in use. While it has not been put to use in papermills, the same application is being given use in other fields, including fast-drying of printing inks. The speaker said it has been adopted by the Chicago-Tribune for drying ink on its high-speed presses and in a paper-coating operation in Wisconsin.

The water used for steam may be re-used, he declared.

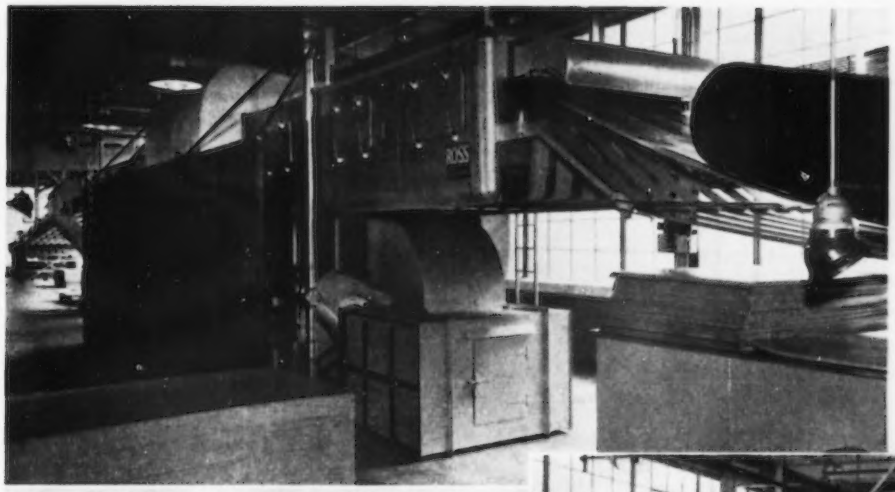
Reginald H. Hurst, Section chairman, presided at the meeting. The speaker was introduced by James A. Dean, program chairman. Dean announced that Dr. Van den Akker, of the Institute of Paper Industry, Appleton, Wis., will speak at the next meeting Dec. 3 on "Significance of Paper Tests."

Whittmore to Address Connecticut Valley Supts.

Lawrence F. Wittemore, president, Brown Co., Berlin, N. H., is to address the January 15, 1954 dinner meeting of the Connecticut Valley Division of The American Pulp and Paper Mill Superintendents Assn. The meeting, designated as Executives Night, will be held at the Roger Smith Hotel, Holyoke, Mass. Invitations to top management of mills in the area to attend the meeting are being extended by individual members of the Division.

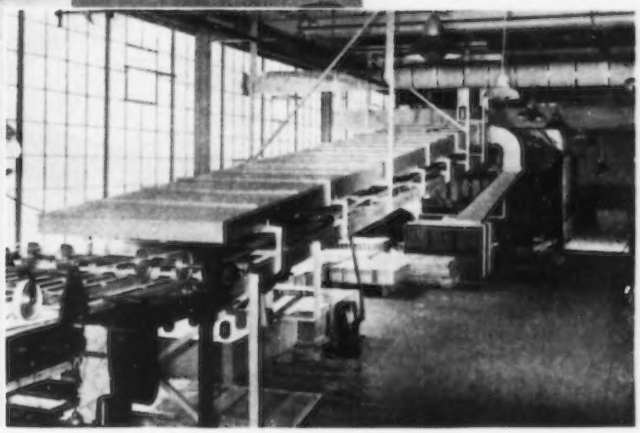
for converting equipment the industry turns to

ROSS . . . *for results!*



At Left:—ROSS Tape Conveyor Dryer with 50 ft. long dryer section and cooling section in rear.

Below:—Delivery end shows the 50 ft. long cooling section of ROSS dryer.



HERE'S VARNISHING EQUIPMENT BUILT TO HANDLE THE HEAVIER GRADES OF STOCK

To apply an overall coat of varnish on label paper or heavy printed board stock THE NEVINS COMPANY, Clifton, New Jersey, operates a WALDRON "Aut-O-Lac" machine and the ROSS Tape Conveyor Dryer shown above. This converting equipment provides not only maximum operating capacity but permits handling stock heavier than 15 point —an unusual accomplishment.

Consult us for all processing that involves synchronized treating, drying and cooling operations. Laboratory testing facilities available.

ROSS RS SYSTEMS

J. O. ROSS ENGINEERING CORPORATION

MANUFACTURERS OF AIR PROCESSING SYSTEMS

444 MADISON AVENUE NEW YORK 22, N. Y.

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ROSS ENGINEERING OF CANADA, LIMITED, MONTREAL, CANADA • CARRIER-ROSS ENGINEERING COMPANY, LIMITED, LONDON, ENGLAND

Southern-Southeastern Hold Record Meeting on the Gulf

An exceptional number of mill men registered for the joint fall meeting of the Southern and Southeastern Division of APPMSA, October 28-30, at Edgewater Gulf Hotel, Edgewater Park, Miss. Among the large contingent of papermakers were the vice-presidents of six paper companies. Total of Superintendents, Affiliates, and wives reached a record 378.

Technical Sessions

During the first two days, panels and papers of high quality were presented at the well-attended technical sessions. Under the leadership of Clyde Jones, R. W. Mizell and E. H. Jones of Crossett Paper Mills presented a report on "Present Status of Digester Corrosion in the South". Then, C. S. Heustis, vice-president, Southern Paperboard Corp. discussed latest developments in "Cylinder Machine Operation".

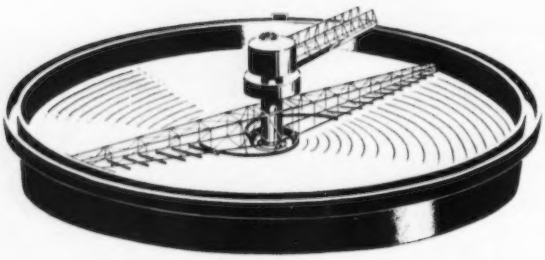
At the Wednesday afternoon section, Charles McCarthy presided over the presentation of "Operation of the Breaker Stock on Fourdinier Kraft" by Russell T. Hudson, Union Bag & Paper Co.; "Planned Maintenance" by James Corbitt, Brunswick Pulp & Paper Co.; and a panel of Howard Wehr, Mead Corp., R. E. Bingham, St. Joe Paper Co., James Loving, West Virginia Pulp & Paper Corp., which discussed "High-Yield Pulping".

The Thursday morning meeting under the direction of T. R. Barnes featured Arthur Ross, vice-president, Southern Kraft Div., International Paper Co., who spoke at length on the importance to all industry of enlightened "Personnel Relations". Following this address, R. C. Skillman, Champion Paper & Fibre Co., presented "Deep Roots", one of three new color films sponsored by Champion to publicize the industry. This film, a dramatic sequence on southern forestry, so captivated the viewers that they prevailed on Mr. Skillman to hold a showing later in the day of the other two films: "Good Business" and "Paper Work". (A feature review of these films appeared in *Paper Trade Journal* October 9.)

A long and extremely informative open

SOUTHERN DIVISION OFFICERS: Retiring Secretary Paul Fenson and Retiring Chairman Tom Coldewey — both of St. Joe Paper Co.

OUTSTANDING PAPERS WERE PRESENTED by (left) James Corbitt (Brunswick Pulp and Paper) on Planned Maintenance; Russell Hudson (Union Bag) on Breaker Stock Operation.



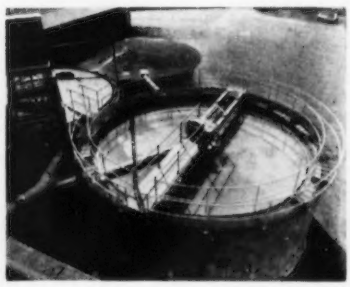
HARDINGE THICKENERS
for
"White Water" Recovery

Hardinge Thickeners have proven their worth in paper plants for removal of settleable solids and in recovering fiber and filler from white water, leaving it sufficiently clear to be reused in the process. They may also be used for clarifying the plant water supply.

In localities where water rates are high, your own water supply or waste water treating system can save you money.

Hardinge Thickeners are available with either steel or concrete tanks. Their scraper mechanism removes solids rapidly through a central discharge. They are also used in conjunction with chemical treatment and flocculation.

State your water problem; write for Bulletin 31-D-14.



Typical Hardinge Thickener installation removing solids from paper plant waste water before reuse in the plant.

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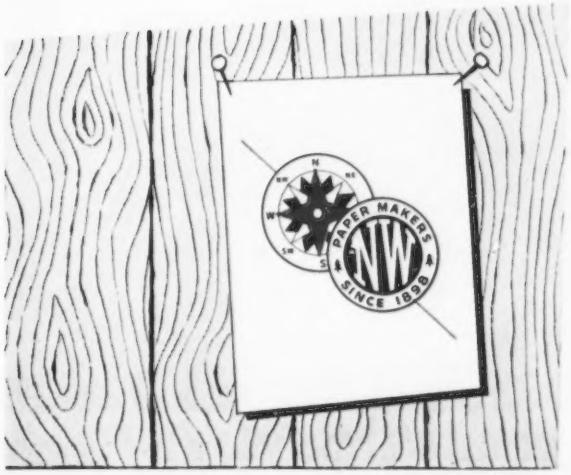

INTERNATIONAL WIRE WORKS

Fourdrinier Wires

MENASHA, WISCONSIN

PARTY SMILES OF THIS GROUP REFLECT THE HAPPY SPIRIT OF THE MEETING. (L to R) Mr. and Mrs. M. E. King; Mr. and Mrs. S. R. Brown; Mr. and Mrs. R. W. McCormick; Otha Winningham — all of National Container; H. B. (Whitey) Wilson, Pusey and Jones.

WATER REMOVAL PANEL — (L to R) John Hoover, West Va. Pulp and Paper Co.; Carl Plumles, Fleming and Sons; Russ Hudson, Union Bag; Malcomb Bollett, Gaylord Containers; John McDermott, St. Regis; Sven Fahlgren, Bird Machine; Carley Smith, Gaylord Container. Mr. Hudson is 1954 Chairman of Southern Division.

Waste Paper
We are always in the market for combination truckloads or carloads of high grades and specialties
PIONEER PAPER STOCK COMPANY

COMPETITION FOR SMALLEST FISH WAS KEEN. Jack Jackson (left) of Ohio Knife inches out Frank Landis of Bauer Bros.

AT LEFT — SOUTHEASTERN OFFICERS: New Chairman Clyde Jones; New First Vice-Chairman Rudy Barnes; New Third Vice-Chairman M. L. Boinest, Jr.; Retiring Chairman V. K. Shannon.

AT RIGHT—HIGH-YIELD EXPERTS: (L to R) National Fifth Vice-President Howard Wehr, Mead Corp.; Moderator and new Southern First Vice-Chairman Charles McCarthy, Southern Paperboard; R. E. Bringham, St. Joe Paper Co.; James Loving, West Virginia Pulp and Paper.

discussion followed the Thursday P.M. panel presentation of papers on "Water Removal". Formal reports were delivered by John Hoover, West Virginia Pulp & Paper Co. and Malcomb Bollett, Gaylor Container Corp. Other members of the panel were the moderator John McDermott, St. Regis Paper Co.; Sven Fahlgren, Bird Machine Co.; Russell Hudson, Union Bag & Paper Co.; Carl Plumles, Fleming & Sons; and Carley Smith, Gaylor Container.

Guest Speakers

At various gatherings over the three-day schedule, the convention was honored by addresses from I. B. Meadows, mayor of Gulfport, Miss.; W. H. Brydges, APPMSA Trustee; W. B. Mills, vice-president, St. Joe Paper Co.; Donald Dick, APPMSA national president; Burke Morden, national affiliates chairman; and Howard Wehr, national fifth vice-president.

Honors and Awards

Sam E. Crocker, John W. Bolton & Sons, explained the purpose and accomplishments of the Bolton Award competition and announced this year's prize papers on the subject "The Obligation of a Company to Its Employees." Southern Division award winner was R. H. Worrell, Southland Paper Mills, Inc., Southeastern Division winner was W. H. Ryon, Ecusta Paper Corp.

Al A. Nyitray, Eastwood Nealley Corp., presented a memorial gift in the name of the late Gene Bechard, which was received by Mrs. Gene Bechard, Eastwood Nealley. A gift of recognition for long and devoted service to the industry was bestowed on W. S. Rooney, Albany Felt Co.

SONOCO PAPER MILL AND SPECIALTY

MADE TO YOUR SPECIFICATIONS

for

- Wax Paper
- Newsprint • Fine Papers
- Carbon Paper • Blue Print Paper
- Adding Machine and Cash Register Paper
- Or any paper that can be wound on a core!

True precision! Outside diameters held to close tolerance with smooth or rough surfaces in convolute or spiral wound. Sizes ¼" O.D. and up, in lengths from ½" to 24', with any practical wall thickness. Supplied colored throughout or with special outside wrap or inside liners. Can be printed inside, outside or on ends.

For paper mill use, Sonoco offers the extremely tough non-returnable RHINO core in all standard sizes. Also available are the returnable DURO and EN-DURO cores with metal ends to fit a 3" shaft. These superior cores meet demands for strength and service at lowest cost.

Our complete laboratory and engineering service will work in helping you solve any core problem.

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DEPENDABLE SOURCE OF SUPPLY

Officers and Business

The Southern Division of APPMSA under Chairman Tom Coldewey was host to the convention. The Southeastern Division was co-host under Chairman Vince Shannon. P. S. Tenson, Southern Division secretary, and M. L. Boinest, Jr., Southeastern Division secretary, labored hard to register the group.

At the Southern Division business meeting the following slate of officers for 1954 was presented and accepted: Chairman Russell T. Hudson, asst. paper mill supt., Union Bag and Paper Corp.; first vice-chairman Charles McCarthy, plant mgr. and vice-president, Southern Paperboard Corp.; second vice-chairman Albert G. Rozyskie, mill mgr., International Paper Co., Southern Kraft Div., Camden, Ark.; third vice-chairman William C. Hayes, paper mill supt., National Container Corp., Valdosta, Ga.

New officers for the Southeastern Division are: chairman Clyde G. Jones asst. gen. supt., Ecusta Paper Corp.; first vice-chairman T. R. Barnes, supt. pulp prod., Champion Paper and Fibre Co., Canton, N. C.; second vice-chairman R. B. White, supt. paper mills, Sonoco Products; third vice-chairman M. L. Boinest, Jr., paper mill supt., Halifax Paper Co.

Members of Southeastern also voted to bestow a $200 annual scholarship award to the North Carolina State School of Forestry. The award shall be assigned each year to a worthy Junior student selected by the college, the only stipulation being that the student be a native of District of Columbia, Virginia, West Virginia, East Tennessee, North Carolina or South Carolina, which area comprises the Southeastern Division.

Special Events

The leisure hours of the convention goers were well provided for. Various committees had arranged a seafood jamboree and barbecue and a banquet-dance, competitions in golf and deep sea fishing, and two extensive bus tours for the ladies.

Chicago TAPPI Learns Retail Packaging Problems

Packaging needs at the retail level were discussed by Val Bauman, National Tea Co., at the October meeting of the Chicago Section of TAPPI. About 50 members and guests were present at the Chicago Bar Association when the speaker presented his views on today's packaging. Presiding at the meeting was Chairman Ed C. Berg, Ace Carton Corp., and the speaker was introduced by Charles Krebs, Atlas Boxmakers. Mr. Bauman first gave some of the history and the activities of the National Tea Co., which is the sixth largest in the food store chains in the United States, accounting for something like 12.7% of sales. The first point stressed by the speaker was that in his opinion packaging was primarily a service function to manufacturers, and he believed the packaging suppliers could very well pattern after some of the better service organizations set up by large manufacturers. He believed that by properly servicing an account, not only at the time the sale was made, but through delivery of the product and between sales, the packaging supplier proved himself ready to accept responsibility and to give his customer the benefit of his specialized knowledge in the field.

The speaker's talk was brief, but a lively question-and-answer period rounded out the meeting, with many interesting phases of packaging and retailing being covered by Mr. Bauman in response to queries from his audience on various aspects of packaging and merchandising.

Mutual Buys Hubbs & Howe Tonawanda Equipment

Mutual Paper Co., Inc., 202 Coffey St., Brooklyn 31, N. Y. has acquired the garment bag machinery and equipment of the Hubbs & Howe Co., Tonawanda, N. Y. This equipment was to be in operation at the Brooklyn plant about the 10th of this month.

Bemis Bro. Buys Flexible Package

All outstanding stock of the Flexible Package Co., Chicago, has been purchased by Bemis Bro. Bag Co. Present plans are to operate the Flexible Package Co. under the same name, and under the same managerial and operational personnel, as a wholly owned subsidiary.

The Flexible Package Co., one of the pioneers in the polyethylene bag business, makes polyethylene bags of all kinds and sizes, including liners. Flexible recently also started the manufacture of bags made from Polycel, which combines the features of cellophane and polyethylene and offers an ideal solution to many current packaging problems.

Wood Flong Entertains Newspaper Craftsmen

Twenty-three members of the Newspaper Craftsmen of New York lately visited the Wood Flong Corp. mill at Hoosick Falls, N. Y. and were treated to luncheon and a guided tour of the mill. Wood Flong is a leader in the limited field of dry mat matrix papers for newspaper stereotyping.

The craftsmen club, which is made up of the mechanical supervisors of New York City newspapers, expressed interest in the technical details that enter into dry mat production. The visitors' attention was particularly drawn to Wood Flong's latest equipment and controls.

Change Status of Paper Study at Western Michigan

After five years as the paper technology curriculum of the chemistry department, a change will be made January 1 at Western Michigan College with the creation of the paper technology department. Dr. Alfred H. Nadelman, curriculum director almost since its inception in 1948, will become head of the new department on that same date.

The paper technology program is developing rapidly and so many things are taking place that it needs separate administration.

PAPER PEOPLE

Donald Lichty Named Nepco Controller

Donald Lichty has been appointed controller of Nekoosa-Edwards Paper Co., Port Edwards, Wis. He joined the Nepco organization in 1933. He first worked in the technical department testing pulp and paper and also in the main laboratory. Later he transferred to the standards department at its inception and established the foundation for a standard cost system coordinated with the accounting department. In addition to being in charge of mill accounting and costs, Mr. Lichty was active in the organization of Nepco's Canadian subsidiary, the Alexander-Clark Timber Co., of which he is treasurer. He also participated in the establishment of the Nepco Retirement Plan and serves on its administrative committee. He has been assistant controller since July, 1952.

Jeffery Named Supt. at Coosa River

J. Borden Jeffery has been named paper mill superintendent of Coosa River Newsprint Co. Mr. Jeffery has been with the Coosa River organization since the start-up of the plant. He brings to his new position a wealth of experience in the manufacture of newsprint, covering a period of over 35 years. In his native Canada, he started with the Spanish River Pulp and Paper Co. mill in Ontario. Later he joined the Spruce Falls Pulp and Paper Co. mill in Kapuskasing, Ontario and was with that organization for 21 years. In 1949, he transferred to Coosa River.

Hafstrom Retires

J. R. Hafstrom has retired as traffic manager of the Marathon Corp., Menasha, Wis., after 34 years of service.

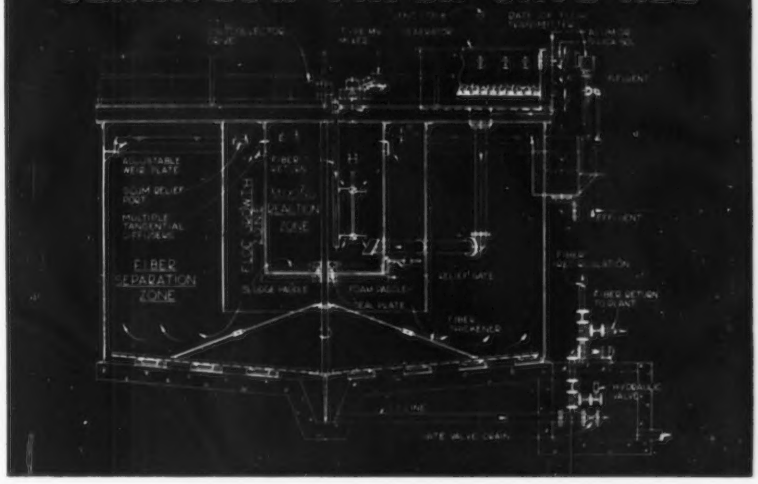
K.C. Transfers Kelley and Pickett

Two transfers from Niagara Falls, N. Y. to Wisconsin were announced by Kimberly-Clark Corp.

Paul Kelley, cost accountant at the creped wadding mill, will leave for Neenah to work in the internal audit division of the comptroller's department in the main office of Kimberly-Clark. He has been associated with Kimberly-Clark for the last six years.

Bruce Pickett, technical superintendent at the creped wading mill, also leaves to become technical superintendent of the Neenah Mill.

CLARIFLOW PAPER SAVE-ALL



Installation at Paper Products Company, Swarthmore, Pa.

WALKER PROCESS CLARIFLOW SAVE-ALL

White Water Waste Treatment

CLARIFLOW PAPER SAVE-ALL MEETS STIFFENED REQUIREMENTS OF STATE BOARDS

The highly clarified effluent can be returned as clear water.

Contact partial vacuum degasifier reduces and may even eliminate the coagulant requirement. Flow through the Clariflow Save-All is staged for maximum chemical reactions and is a true vertical rise tank. Thickener mechanism discharges stock thick enough to be returned to stock chest.

WRITE FOR CLARIFLOW BULLETIN NO. 16-1-76

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FACTORY • ENGINEERING OFFICES • LABORATORIES
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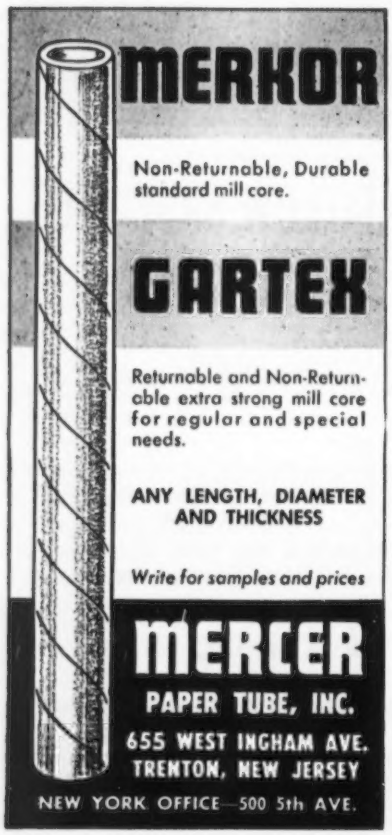
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Non-Returnable, Durable standard mill core.
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Returnable and Non-Returnable extra strong mill core for regular and special needs.
ANY LENGTH, DIAMETER AND THICKNESS
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PRICES

MARKET WOOD PULP

Fourth Quarter Contract Prices Per Short Air-Dry Ton

	Delivered Basis		Varying Freight Allowances		
	U.S.	Canadian	Swedish	Finnish	Norwegian
Groundwood		‡$60.00/$95.00*	*$80.00/$85.00*	$$78.00/ —	$75.00/$80.00§
Kraft, Bleached	140.00/147.50	145.00/155.00	§137.50/140.00§		§137.50/145.00*
Semi-bleached, Kraft	135.00/ —	130.00/135.00	§132.50/135.00§	135.00/ — *	
Kraft, Unbl.	95.00/105.00	95.00/135.00	*100.00/105.00*	100.00/105.00*	100.00/105.00§
Sulphite, Blchd.	140.00/ —	140.00/ —	§132.50/140.00*	140.00/ — *	§130.00/145.00§*
Sulphite, Unblchd.	120.00/ —	120.00/ —	§110.00/120.00*	120.00/125.00*	
Sulphite, Unbl. Glassn.		124.00/ —	*124.00/ —		
Soda, Blchd.	140.00/ —	140.00/ —			

‡ F.o.b. Shipping Point. § On Dock Atlantic Ports. * Freight allowed.

RAG MARKET

New Domestic Cotton Cuttings
Delivered Mill Basis

	Per 100 lbs.
No. 1 White Shirts	$12.50/$12.75
No. 1 Unblchd. Muslins	13.50/ 13.75
Blchd. & Unblchd. Underwears	14.50/ 15.50
Blchd. Canton Flannels	11.00/ 11.50
No. 1 Light Silesias	8.00/ 8.50
No. 1 Light Prints	6.50/ 7.00
No. 1 Blue Overalls	7.00/ 7.50
Suntan Khakis	6.25/ 6.75
Fancy Shirts	6.50/ 7.00
Mixed Khakis	4.00/ 4.25
Cottonades	4.25/ 4.50
No. 1 Washables	3.25/ 3.50

Old Domestic Cotton Rags
(Prices to Dealers, F.o.b. Ship. Pt.)

	Per 100 lbs.
Mixed White	$2.75/$3.00
Cotton Pants & Overalls	2.00/ 2.25
Thirds and Blues, Repacked	1.55/ 1.65
No. 2 Roofing Rags	.80/ .85

COTTON LINTERS

Memphis Market
F.o.b. Oilmills

	Nov. 3 Per 100 lbs.
Grade 1 n.a.	
2	$12.50/ $9.50
3 1st cut—felting	9.00/ 8.00
4	7.50/ 5.00
5	4.50/ 3.75
6 * 2nd cut—chemical	3.50/ 3.50
7	3.50/ 3.50

* Based on 73% cellulose.

Bagging
(Prices to Dealers, F.o.b. N. Y.)

	Per 100 lbs.
Foreign Gunny	$3.75/$4.00
Heavy Wool Tares	4.00/ 4.25
Foreign Scrap Burlap	2.75/ 3.00
Austr. Wool Pouches	3.50/ 4.00
Domestic Manila Rope	6.50/ 7.00
Domestic No. 1 Sisal Strings	5.00/ 5.25

WASTE PAPER MARKET

Prices to mills, per ton, f.o.b. cars shipping point (includes brokers' fees.) These quotations are a partial indication of the price range on volume tonnage in each market on the date specified, as gathered from major dealers. SPECIAL PACKINGS AND SPOT TONNAGE NOT INCLUDED. Prices nominal. See TRENDS.

	N.Y.-Phila. Nov. 10	Boston Nov. 7	Chicago Nov. 9	Los Angeles Oct. 3
No. 1 Mixed Paper	$12.00/ 15.00	$10.00/ 11.00	$12.00/ —	$15.00/ —
No. 1 News	14.00/ 17.00	14.00/ 15.00	17.00/ —	15.00/ —
Overissue News	20.00/ 22.00	14.00/ 16.00	20.00/ —	15.00/ —
Mill Wrappers	20.00/ 22.50	13.00/ 15.00	15.00/ —	14.00/ —
Old Corrugated	21.00/ 24.00	20.50/ 21.00	23.00/ —	23.00/ —
Double Kraft Ld. Corr. Cuts	35.00/ 47.50	37.50/ 47.50	40.00/ 47.50	35.00/ 45.00
100% Kraft Corr. Cuts	60.00/ 62.50	50.00/ 60.00	60.00/ —	45.00/ —
No. 1 Brown Kraft	30.00/ 35.00	35.00/ 45.00	25.00/ —	45.00/ —
Triple Sorted Brown Kraft	40.00/ 45.00	42.50/ 50.00	— / —	—/ —
New Br. Kraft Env. Cuts	70.00/ 75.00	65.00/ 77.50	65.00/ —	50.00/ 55.00
New Br. Kraft Bag Waste	65.00/ 70.00	65.00/ 75.00	70.00/ —	40.00/ 45.00
No. 1 Gdwd. Shvs	25.00/ 30.00	25.00/ 30.00	22.00/ —	27.00/ —
White Newsblanks	55.00/ 60.00	50.00/ 60.00	40.00/ —	55.00/ 60.00
No. 1 Soft Wht. Shvs	65.00/ 70.00	70.00/ 80.00	60.00/ —	— / —
Hd. Wht. Shvs	95.00/100.00	95.00/110.00	85.00/ —	95.00/ —
Hd. Wht. Env. Cuts	120.00/130.00	110.00/125.00	100.00/ —	105.00/ —
Col. Tab. Cards	47.50/ 57.50	55.00/ 60.00	50.00/ —	24.00/ —
Manila Tab. Cards, box, bales	72.50/ 80.00	75.00/ 85.00	70.00/ —	47.50/ —
Mixed Ledger	40.00/ 45.00	40.00/ 50.00	50.00/ —	26.00/ —
White Ledger	57.50/ 65.00	60.00/ 65.00	65.00/ —	40.00/ —
No. 1 Book & Mag.†	18.00/ —	18.00/ 22.50	15.00/ —	— / —
No. 1 Rep'd. Hvy. Books‡	30.00/ —	25.00/ 35.00	30.00/ —	— / —

† Includes Time & Life; no coarse groundwood. ‡ Not to exceed 10% groundwood. § Deld.

PRICES OF MATERIALS

Aluminum sulfate:		
cml. bags, c.l. wks.	cwt.	$1.85 / —
iron-free, c.l. wks.	cwt.	3.55 / —
Casein, acid prec.:		
dom. sh. pt. c.l.	lb.	.27 / .37½
imp. ex. dock	lb.	.21½/ .25
Caustic soda:		
c.l. wks. solid, 76% cwt.		3.70 / —
flak. & grd. 400-lb. drums, c.l.		4.10 / —
liquid 50% tanks		2.55
liquid 70% tanks		2.65
China clay:		
dom. air-float, c.l. wks.	ton	10.00
water-washed, lump, filler		11.00
coating		17.60 /30.50
imported, ex. whse.	short ton	16.00 /29.50
Chlorine:		
single-unit tanks, works	cwt.	2.93 / 3.03
multiple unit, 2-5 cars per yr.		3.80 / 5.10
Formaldehyde:		
USP, inh. dms. c.l. wks.	lb.	.0666/ —
l.c.l., E. wks.		.071 / —
Fuel oil:		
Bunker C, No. 6 hvy. tanks, N.Y. harbor	bbl.	2.25 / 2.28
Lime:		
hydrated bags, wks.	tons	14.50 /15.50
Gum rosin:		
K, M, N, drms, c.l. Savan.	cwt.	7.70 / 7.80
Rosin size:		
70%, gum & pale grds., tank cars, south, sh. pt.	cwt.	6.60 / 6.65
Salt cake:		
dom. bulk, c.l. wks.	ton	19.00 / —
Soda ash:		
light, 58%, bags, wks.		1.65
bulk	cwt.	1.35
Sodium silicate, 40° Be.:		
tank-cars, wks.	cwt.	1.00 / —
drums, wks.	cwt.	1.35 / —
42° Be. WW, tank-cars, wks.	cwt.	1.60 / —
drums, wks.	cwt.	1.95 / —
Sodium peroxide:		
dms. c.l. E. of Miss.	lb.	.186
l.c.l. do	lb.	.191 / .201
Soybean, protein:		
chem. isol., wks. c.l. bags	lb.	.23 / .23½
Sulphuric acid:		
60° Be. chys. c.l. wks.	cwt.	1.75 / 2.00
l.c.l. wks.	cwt.	2.30 / 2.45
tank-cars, wks.		16.30 /18.60
Sulphur:		
crude, c.l. mines, contract,	long ton	25.50 /27.50
f.o.b. vessels Gulf		27.50 /30.50
Sulphur dioxide:		
liquid, coml. cyl., wks.	lb.	.09
multi-unit cars	lb.	.0535
Starches:		
pearl corn, bags, c.l. prod. plant		6.39 / —
white dextrines, c.l. do.	cwt.	7.78 / —
potato, Idaho, c.l. wks.	cwt.	6.50 / —
potato, Maine, f.o.b. wks.	cwt.	nominal
potato, imported, O.D.	bags	7.65 / 8.20
tapioca, med. Java, O.D.	cwt.	6.75 / —
Talc:		
domestic, sacks, c.l. wks.	ton	25.00 /30.00
Titanium dioxide:		
anatase, c.l. deld. E. bags	lb.	.22½/ .23
l.c.l. deld.	lb.	.23½/ .24
rutile, c.l. deld.	lb.	.24½/ .25
l.c.l. deld.	lb.	.25½/ .26

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SODA ASH

Highly uniform; many grades. Let Wyandotte Technical Service explain how you can adapt your processes to produce your own sulphite liquor at a savings!

CAUSTIC SODA

Our liquid caustic may save you time and labor in handling, storage, use. Soda bleach foams less than lime bleaches; lowers chlorine losses, speeds draining and drying, insures cleaner finished paper with a minimum reversion of brightness.

CHLORINE

Investigate our liquid chlorine for bleaching and bleaching compounds, for direct chlorination of wood and waste paper pulps and for water treatment. Tested shipping methods assure safe delivery and trouble-free operation in your plant.

KREELON*

Wyandotte's alkylarylsulfonate is highly soluble; gives fast, effective wetting; increases absorbency of tissue and blotting paper. In proper formulation KREELON is particularly effective in deinking operations where peroxide bleach is prepared.

PLURONICS*

Mill evaluations show that PLURONIC F68, the only 100%-active flake nonionic surfactant, improves absorbency and softness of paper towels. It is an excellent paper softener, with a minimum reduction in strength. PLURONIC F68 with sulfamic acid is excellent for washing felts . . . increases felt-life as much as 100%.

PURECAL*

Wyandotte's ultra-white precipitated calcium carbonate is exceptionally uniform in quality and particle size, free of grit and abrasives, readily and easily dispersed. PURECAL produces a smooth coating of high whiteness, good hiding power, and excellent inking qualities.

CARBOSE*

CARBOSE I, added to the beater aids in deflocculation of the pulp resulting in better sheet formation. CARBOSE VI, applied at the calender stack to patent-coated board, improves grease resistance resulting in improved gloss of ink . . . when applied at the calender stack in the manufacture of jute liner, it results in an increase of 5-20% in Mullen strength.

Contact Wyandotte for skilled technical service to assist you with production, handling or storage problems. Write for data on, and samples of, chemicals for the paper industry.
Wyandotte Chemicals Corp., Wyandotte, Mich. Offices in principal cities.

*REG. U.S. PAT. OFF.

Wyandotte CHEMICALS

NEWS OF SUPPLIERS

R. G. Thibault

C. W. Raby

• THEW SHOVEL CO., Lorain, Ohio, has appointed R. G. Thibaut as service manager and C. W. Raby, assistant service manager. Mr. Thibaut succeeds R. P. Kelly who recently passed away.

Mr. Thibaut, who has been associated with the shovel and crane industry since the age of 14, joined the firm in 1936 as assistant service manager. He previously was a field service engineer working in Thailand and other Far East countries. Mr. Thibaut will be responsible for the servicing of Lorains in the field throughout the world.

Mr. Raby joined Thew 26 years ago, serving as traffic manager, manager of Field Service and now, assistant service manager.

• LAMSON CORP. of Delaware has acquired as of November 1, 1953, the fork lift truck business of Mobilift Corp., Portland, Ore. A new Oregon subsidiary, Lamson Mobilift Corp. will take title to the assets being purchased and carry on this fifteen year old business as an integral part of the Lamson line of materials handling equipment.

By adding a series of fork lift trucks to its line of belt and roller conveyors, Automatic Pallet Loader, pneumatic tubes, blowers, and related types of materials handling equipment, the company has become the first manufacturer to offer a completely integrated line of materials handling equipment and engineering services.

The Mobilift assets that Lamson acquires include all the equipment, machinery, and inventory at the company's manufacturing plants at Portland and at its five sales, service, and parts branches at Berkeley, Calif.; Dallas, Texas; Chicago, Ill.; Atlanta, Ga.; and Rutherford, N. J. The Mobilift nationwide dealer organization and sales force located at national industrial centers throughout the country will be continued.

• MAINTENANCE ENGINEERING CORP., Houston, Texas, sales representatives for Graver Water Conditioning Co., has added Alvin S. Vener to its staff of engineers. He has been a process engineer for several Texas concerns. Much of his industrial experience has concerned water treatment, which will occupy most of his time at Maintenance Engineering Corp.

• FOXBORO CO., Foxboro, Mass., has opened a branch office in Amarillo, Texas, located at 1117 La Paloma street. Assigned to the office as industrial engineer is D. T. McElligott.

• MONSANTO CHEMICAL CO.'s first polyethylene production plant will be located at Texas City, Tex. Construction work is now under way. Contractor is Farnsworth and Chambers of Houston, Tex.

Located adjacent to Monsanto's existing Texas City plant, the new polyethylene unit, operated by the Plastics Division, is expected to produce commercial quantities of polyethylene starting the fourth quarter of 1954. Plans announced last March set initial annual capacity at about 66 million pounds, with a 50 per cent increased capacity scheduled for 1957. At that time the site had not been chosen.

• MINNEAPOLIS-HONEYWELL REGULATOR CO.'s Philadelphia training school has set schedules for industrial instruments maintenance and repair courses for the first half of 1954.

The division again listed a 14-weeks comprehensive class which it offered for the first time last year to include instruction in new devices. Other Honeywell customers' courses include two five-weeks sessions and several running up to three weeks, said Martin J. Ladden, chief instructor of the school. The courses are now in their 18th year.

The 14-weeks comprehensive course will be held from Feb. 15 to May 21. The two five-weeks courses will start Jan. 4 and April 26. Shorter courses will start Feb. 15, March 8, April 5, and June 7.

AMERICAN PAPER AND PULP ASSOCIATION'S PAPER PRODUCTION RATIO REPORT

(Production as per cent of normal capacity)

COMPARATIVE WEEKLY SUMMARIES

1953	Oct. 3 97.2	Oct. 10 98.3	Oct. 17 97.3	Oct. 24 97.1r	Oct. 31 96.9
1952	Oct. 4 89.6	Oct. 11 90.7	Oct. 18 90.1	Oct. 25 92.0	Nov. 1 91.3

COMPARATIVE MONTHLY SUMMARIES

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year Avg.
1952	**97.1**	**97.8**	**95.1**	**90.4**	**87.9**	**87.6**	**73.3**	**86.1**	**81.7**	**90.7**	**90.5**	**85.3**	**88.6**
1953	94.5	94.6	94.4	92.7	93.9	94.2‡	82.6‡	92.5‡	93.7‡	97.4‡			

COMPARATIVE YEARLY SUMMARIES

	1946	1947	1948	1949	1950	1951	1952	1953
Year to Date	101.3	101.3	97.1	87.6	95.9	99.9	90.5	93.3
Year Average	**96.9**	**101.7**	**92.1**	**83.7**	**95.8**	**98.0**	**88.6**	

‡ Preliminary.
r Revised.

PAPERBOARD OPERATING RATIOS †

1953	Oct. 3 98	Oct. 10 97	Oct. 17 97	Oct. 24 97	Oct. 31 96
1952	Oct. 4 95	Oct. 11 96	Oct. 18 97	Oct. 25 97	Nov. 1 97

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year Avg.
1952	97	96	95	87	82	82	71	90	98	96	96	85	85
1953	91	95	95	95	96	93	81	98	94	97			

All of the above data is based on tonnage reported to American Paper and Pulp Association. Does not include mills reporting to National Paperboard Association, except in isolated cases where both paper and paperboard are produced and separate tonnage figures are not readily available. Does not include mills producing newsprint exclusively.

Note: In the above tables *all* the ratios shown are on the basis of a normal 6 and 7 day capacity.

† Per cents of operation based on "Inch-Hours" reported on a 6-day basis to the National Paperboard Association.

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Paris
Zurich
Stockholm
Oslo
Hamburg
Toronto
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Sao Paulo
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Vienna
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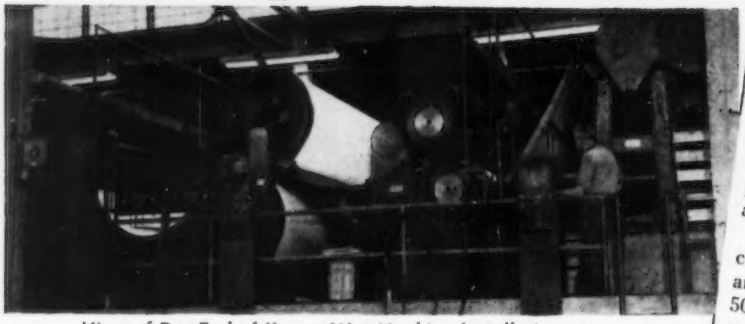
in More and More Mills with
Kamyr Wet Machines



View of Dry End of Kamyr Wet Machine Installation at Consolidated Water Power & Paper Co., Appleton Division Mill

Consolidated's New Kamyr Wet Machine

Consolidated Water Power & Paper Co. has completed installation of a Kamyr wet machine at its Interlake (Appleton) Division pulp mill at an overall cost of $500,000.

The new two-press 156" feltless machine, built by the Sandy Hill Brass and Iron Works, is designed to produce 50 per cent oven-dry wet lap pulp. Company officials stated that this reduction in moisture content will cut shipping costs and that the machine will increase operating efficiency. All but a small amount of pulp produced at this loca-

Economical and Efficient Pulp Sheeting are chief factors in the current upswing in Kamyr Wet Machine sales.

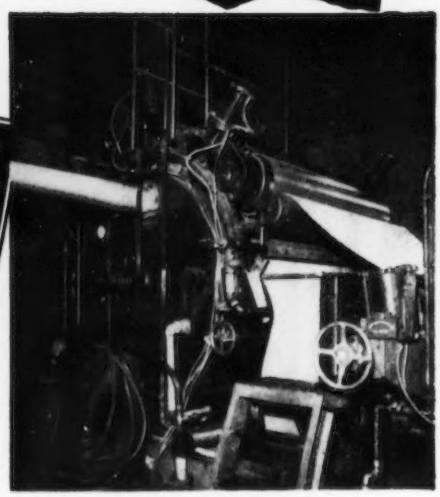
Lower Costs result from:

- Continuous Operation
- Larger Output
- Low Upkeep and Operating Costs
- No Felts
- Long Cylinder Mould Wire Life
- Lower Freight for Drier Pulp

More Efficient Sheeting due to:

- Uniform Consistency
- Greater Dryness
- Cutter Designed for Wet Sheeting
- Sheets of Suitable Size
- Easier Sheet Handling

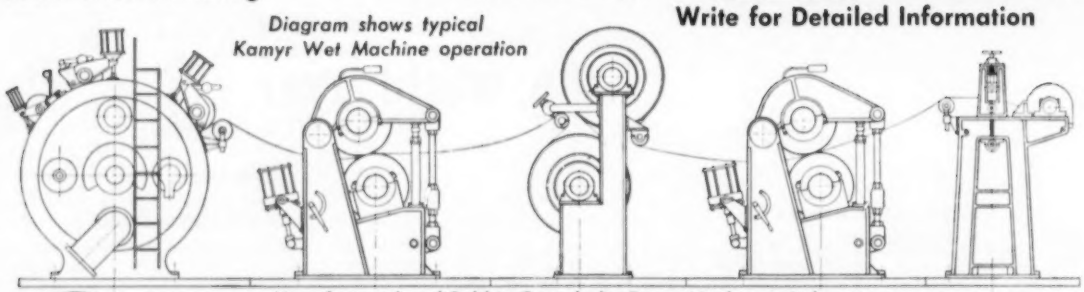
ONE Kamyr Wet Machine regularly replaces 8 to 10 Wet Lap Machines



The Mould Section on one of two recently installed Kamyr Wet Machines in mills of International Paper Co.

Write for Detailed Information

Diagram shows typical Kamyr Wet Machine operation



Manufactured and Sold in Canada by Paper Machinery Ltd.

The Sandy Hill Iron & Brass Works

Hudson Falls, N.Y.

Western Michigan College

Industrial Lectures on Paper and Paperboard Converting

Edited by

Dr. A. H. Nadelman, Western Michigan College
and Martin J. Galbraith, Sutherland Paper Co.

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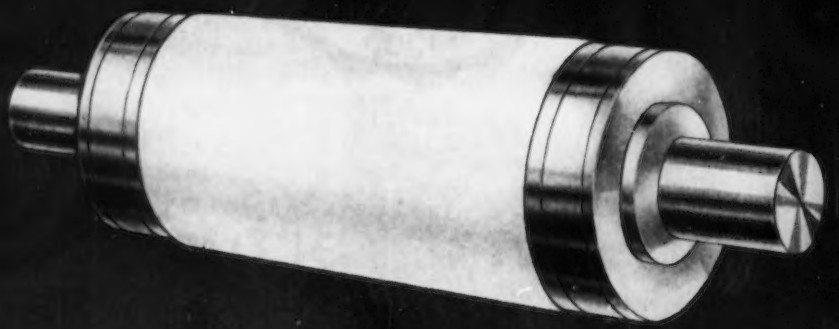
CALENDER ROLLS



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Foreword

We at Paper Trade Journal have been very pleased to be associated with Western Michigan College in the publication of these lectures. This is particularly true since our association goes back to the inception of the idea of the evening courses on the "Converting of Paper and Paperboard," at the college and carried on through the selection of the speakers to the publication of this volume.

The success of the course and this ensuing publication has been almost entirely due to Dr. A. H. Nadelman, Professor of Pulp and Paper Technology at the college, and to Martin J. Galbraith, Technical Director of the Sutherland Paper Co. Probably no one but ourselves is really aware of the efforts Dr. Nadelman and Mr. Galbraith put into the planning and execution of the course and by no means least, the preparation and the editing of the papers for publication.

To Western Michigan College, an important and progressive educational center in a major papermaking and converting region, this volume will serve as a fitting fiftieth anniversary memento. It celebrates completion of five years of its extremely successful course in pulp and paper technology and at the same time marks the college's entry into instruction in the field of paper converting.

John C. W. Evans

Editor
Paper Trade Journal

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Acknowledgement

Western Michigan College launched its program of pulp and paper technology five years ago. In the ensuing years there evolved a curriculum known throughout the United States. It has been unique in that it started and has continued as a cooperative effort between the college, and paper and allied industries.

The close alliance which has grown over the last five years between Western Michigan College and the paper industry has demonstrated the mutual benefit which can be brought about by such an arrangement.

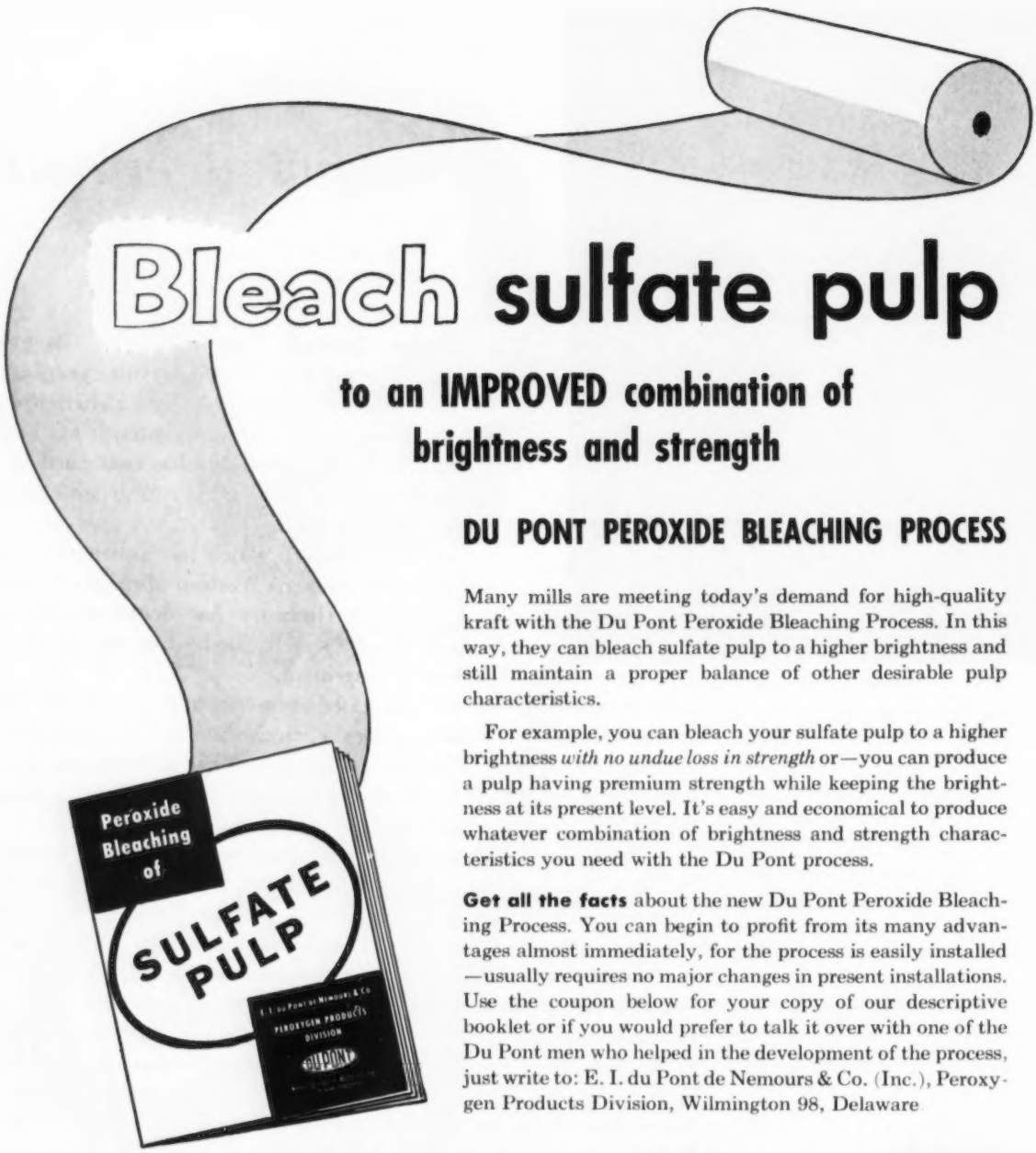
Both the college and the interested industries have nursed this new venture along slowly, developing the curriculum and the equipment to train our students. The assistance and guidance industry has given has been beneficial; it has been the function of the college to direct the program toward a continued growth and betterment.

In the Fall of 1952 the initial program was carried a step further by the addition of an evening course in "Converting of Paper and Paperboard". The enthusiasm this new program received was most encouraging to the school, and I hope that other such ventures of a specific service to the citizens of this area can be effected.

The effort which has been put into this evening series is evidenced in this book, which has been made possible through the efforts of Dr. A. H. Nadelman, Professor of Pulp and Paper Technology, and Mr. Martin Galbraith, Technical Director of the Sutherland Paper Co. The college is deeply grateful to these men and to the *Paper Trade* JOURNAL for their efforts on behalf of this book, which will be used as a textbook for senior students in the pulp and paper curriculum, and in our adult education department.

Paul V Sangren

President, Western Michigan College



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Alfred H. Nadelman

Alfred H. Nadelman, Co-editor of this textbook, has been Professor and Head of the Curriculum of Paper Technology at Western Michigan College in Kalamazoo since 1948. His prior experiences in industry include the positions as Chief Chemist, Milprint, Inc., (1939-1940); Chief Research Chemist, Glassine Paper Co., (1940-1944); and Technical Superintendent, International Paper Co., (1944-1948). His interest in education was shown as lecturer at St. Joseph's College, where he conducted an adult education course on "The Chemistry of Pulp and Paper Making" in 1944. During the second World War he served as Gas Instruction Officer and Gas Identification Officer for the Council of Defense in Philadelphia, Pa.

Holding the degrees of A.M. and Ph.D. of the University of Berlin, Germany and having had additional training at Massachusetts Institute of Technology and at University of Maine, he has been active as member and officer in a number of organizations, the American Assn., for the Advancement of Science, TAPPI, the American Pulp and Paper Mill Superintendents Assn., The American Chemical Society and others.

Dr. Nadelman's interest in Kalamazoo civic affairs includes service as chairman and member of Citizens' and Mayor's Committees.

Martin J. Galbraith

Martin J. Galbraith, Co-editor of this textbook, joined the Sutherland Paper Co., in 1945 as development engineer, a position he held until 1950 when he was appointed technical director for Sutherland. Prior to joining the company he served from 1941 to 1945 as a Naval aviator. He was trained at the Naval Air Station at Pensacola, Fla., and holds the rank of Lt. Commander in the United States Naval Reserve.

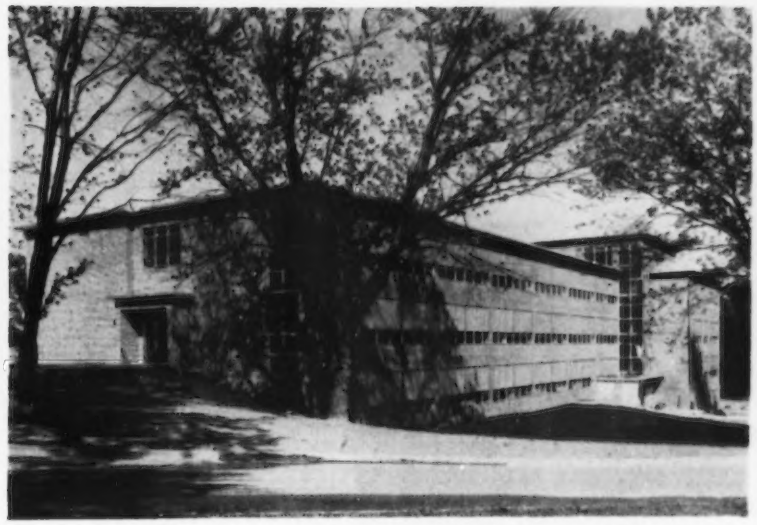
With a background of training at New York University, Mr. Galbraith has been active in various technical groups devoted to the pulp and paper industry since joining Sutherland. He is a member of TAPPI, Packaging Institute, the American Pulp and Paper Mill Superintendents Assn., and is currently serving as a member of the research and technical committee of Folding Paper Box Assn., of America and as a member of the executive committee of the Research and Engineering Council of the Graphic Arts Industry.

He has been active in promoting the pulp and paper curriculum of Western Michigan College in Kalamazoo, and is serving as a member of the Advisory Committee on Paper Technology. Mr. Galbraith is active in Kalamazoo civic affairs having served on the budget committee of the Community Chest and other civic ventures.

AERIAL VIEW OF "NEW" CAMPUS. Upper left hand corner: Maybee Hall for musical education, Kanley Memorial Chapel, McCracken Hall for physical sciences, Administration Building, and Faculty Apartments. Siedschlag and Draper Halls for women and Burnham Halls for men in the foreground.

PROOF PRESS AND PAPER TESTING INSTRUMENTS in the Paper Testing Laboratory.

R. T. ELIAS, Assistant Professor of Paper Technology, at an experimental coater in the Paper Laboratory.



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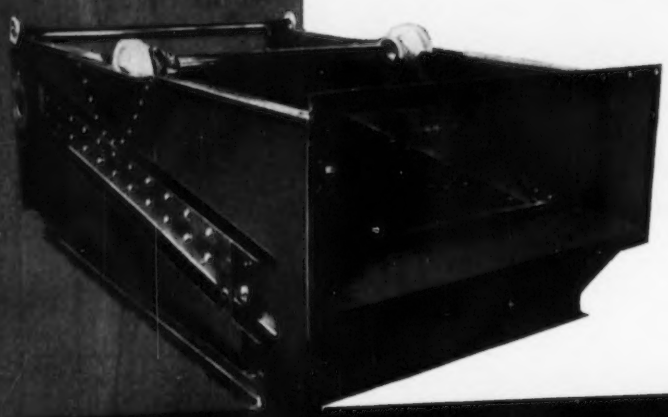
First step to a clean pulp

THE REENER SCREEN



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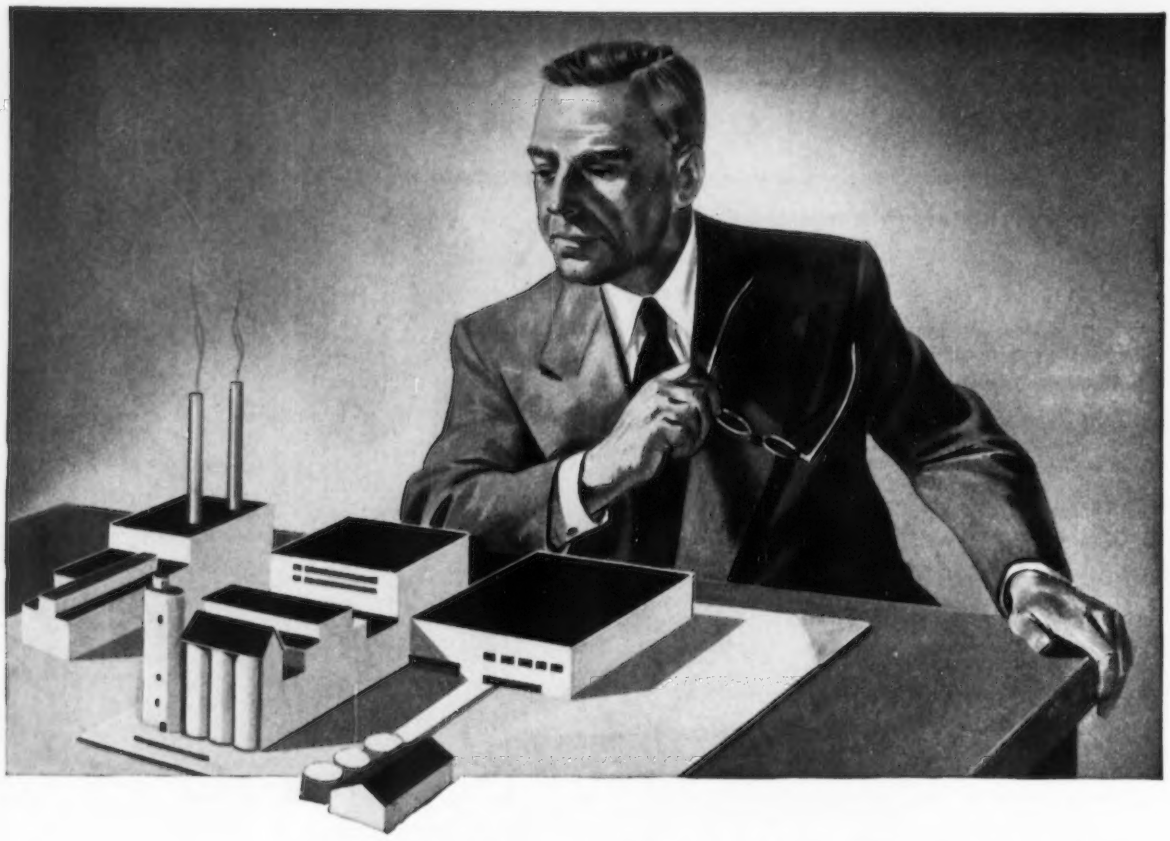

Few Operations Are As Profitable As They CAN Be

Maybe it's worried you. Here's how a paper company we know handled this situation.

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Some Economic Aspects of Paper and Paper Board Converting Industry

By

Henry J. Perry*
Waste Paper Utilization Council

Definitions

At the start of any course it would be well to consider definitions of the materials with which we are to work and study. These definitions will not be long-haired, nor scientifically correct, and will vary according to the viewpoint of the person using them.

What is paper? To most of us it is a more or less carefully arranged mass of cellulose fibers made with great versatility for a multitude of uses for our own personal comfort and convenience. To a scientist it is a mass of a long chain polymer in fibrous form, generally of natural vegetable origin. To a salesman, it is a wonder material which he can supply in almost any form, absolutely uniform in quality and at a low price.

A purchasing agent might think of it as a material which he would like to buy, having the strength of steel, weight of aluminum, the transparency and imperviousness of glass, plus all natural or built-in characteristics of paper itself and at a dirt cheap price. The converting machine operator in polite language would call it that lousy stuff the paper mill foists upon me, from which I am expected to make a product of super quality 100 percent of my working time.

Actually paper is that stuff which makes our American system function as it does, for no industry, no person can live as we do now without paper in some form affecting every second of his life.

What Are Paper Products?

Strangely enough paper and paperboard—which we will consider as be-

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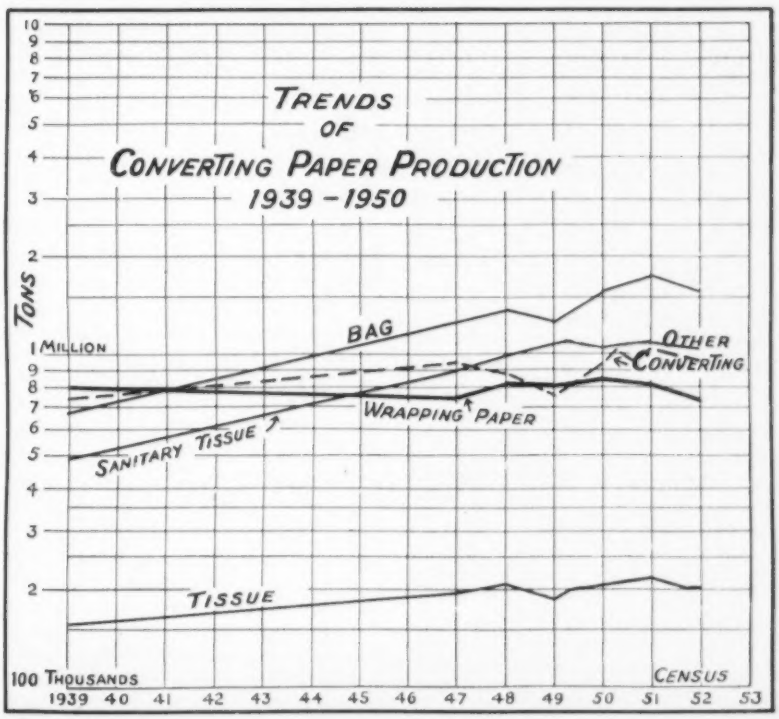
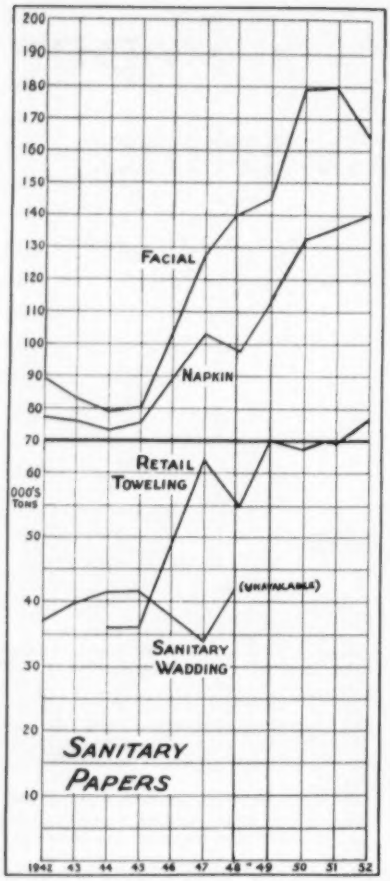
Mr. Perry has been active in many phases of manufacturing, engineering, converting and management within the pulp and paper industry.



* At the time Mr. Perry presented this lecture he was editor of PAPER TRADE JOURNAL.



ing paper for the purpose of this talk —seldom comes into our daily lives as it is made in the mill. In order to meet its responsibilities, it has got to be put in useful form and shape. As paper products, these items tend to sneak into our daily lives almost unseen, unnoticed and certainly unsung. Again we must pause to define what the products are. To the harried husband, it is all those packages in a big carton he lugs home Friday night from the chain store to burn or put on the curb on Saturday morning for the trash collector, after serving their useful life.

But wait a minute! There would not be a chain store, or any of the other modern forms of merchandizing without paper products, nor automobiles, electric light, radios, T. V. or any other modern conveniences. We would still be in the Stone Age, without paper and its products.

The housewife may think of it as the box-top she must send to Hop-along Cassidy for a new two-gun six-shooter set for her young fry. The whole breakfast food business depends on the paper box. Stop a moment, and imagine a wooden barrel full of puffed wheat.

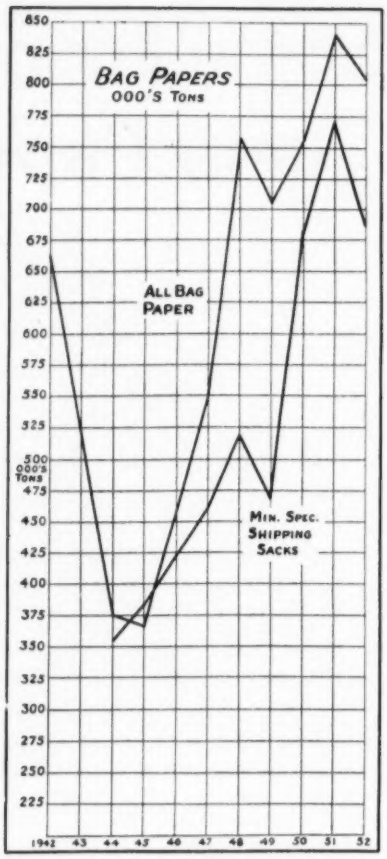
And so it goes, a paper product can be the roof over your head, the inner soles in your shoes, the wallet in your pocket, your pay envelope, the bag that brings home your food. Your everyday existence depends on a paper product.

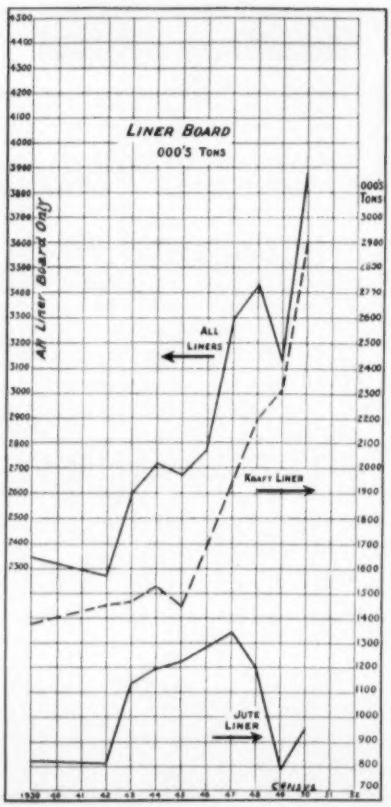
Importance of the Paper Products Industry

The making of comparisons between industries is odious and seldom adds any clarification to the problem.

Using the base period of 1947, we find paper products and their manufacture have had a stupendous growth in the past 20 years. The value of its products in 1947 was 3¼ billion dollars, a rise of 510 percent in 20 years. It employs some 214,000 people, many of them women. Its payroll exceeds a half billion dollars per year.

It is a buyer of other people's products to the extent of nearly 2 billions worth per year, a sizeable consumer of fuel to the tune of nearly 12 million dollars, and its electric power bill is $10,900,000 per year. As a consumer of paper in 1947, the converting industry itself used 12 million tons or about half of all domestic production. Today, the converting industry's volume of business is still higher by an appreciable percentage.



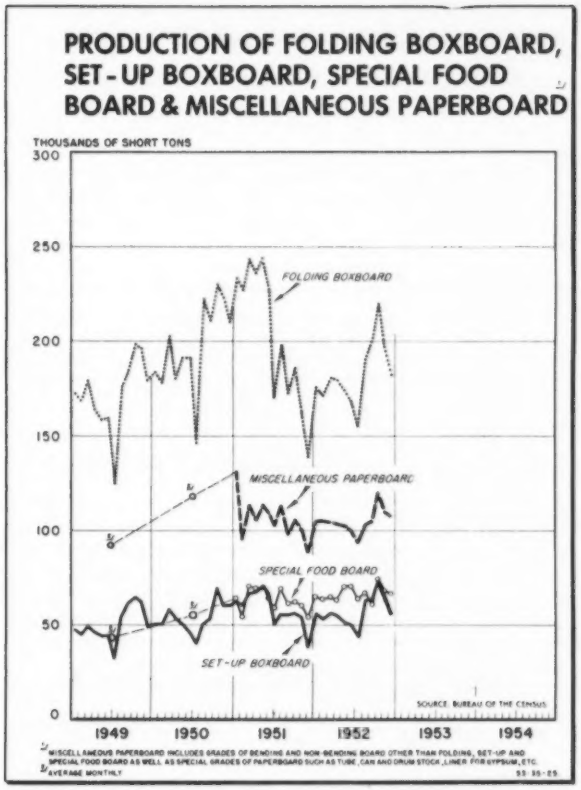


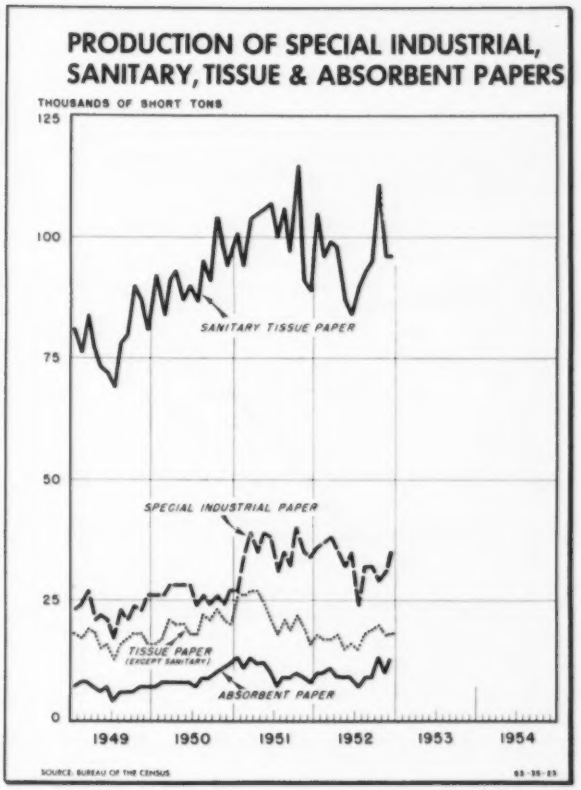
For some time, the trend of the converting industry has been toward integration with its principal raw material suppliers, the paper and paper board industry. In 1939 the Census Bureau reported that there were 213 converting operators connected with paper mill plants. Since that time the trend has become accelerated. As an indicator, in the absence of accurate data, of the 86 major companies listed as having public stock ownership, 51 have converting facilities. All manner of products are made by the integrated company but the heaviest concentration is in the carton, container and bag fields.

Competitive Position

As has been said, paper as such does not enter into our daily lives in the as-made form. As a material it can be modified in almost any manner to fill a need. As this study course progresses, you will learn how it is cut, scored, creased, spun, formed, saturated, glued, stitched, coated, woven, and all the combinations thereof.

Paper products just did not happen to find markets and fill needs. These products are the result of development and the free spirit of competition. Do





not think for one moment that this is one-sided race with paper always a winner, for textiles, glass, leather, plastics and metals are in earnest competition in the paper products field.

Many examples can be found in everyday living. Strangely enough the competing materials are also the most used materials for modifying and reinforcing paper to make useful paper products. Textiles and paper are competitive in many cases. The auto seat-cover is an excellent example. In recent years, various synthetics with fade resistance, longer life, better feel, up-to-date styling, have made serious inroads in the fiber seat-cover market.

In the napkin, towel and table-cloth market, the high cost of domestic labor created a natural market for paper products. However, textiles have answered with an unwoven resinous bound fabric, which fills a quality need still unchallenged by a paper product.

The challenge of paper bags forced feed manufacturers to finer fabrics suitable to clothe the farmer's wife and daughter in times past. Dainty designs became the vogue instead of a checkerboard pattern or burlap. Today with high farm income, nylon and rayon fabrics are none too good for a farmer's daughter and paper may gain a foothold as a feed bag, as the farm women buy rather than make their fineries.

Metal in many forms competes with paper in various cans and containers. Gone are the war babies made from paper for Crisco, other greasy foods lubricating oil, paint or items with long shelf-life requirements. Use requirements of the package plus cost of container is the probable reason. In many cases an equal quality package can be made from paper, but the cost of coatings, treatments, and filling to make a satisfactory package makes it more costly than metal.

In some forms of closures, aluminum foil is giving paper a serious race, both from a cost and use standpoint. Furthermore, plastic films compete with both foil and paper. In some cases, paper comes to the rescue of these materials to make, in combination, a suitable package or wrapper.

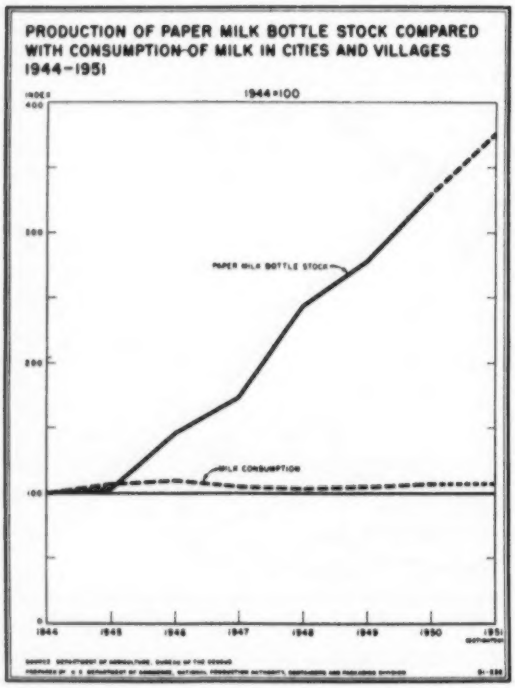
Glass at some points enters a see-saw battle. The battle in the retail milk field is an example. Paper before the war pushed glass from a price angle, plus other favorable factors. Glass came back with a superior bottle that pushed paper around. At present, with paper becoming more freely available, the paper trend is upward. This example can also be cited as an example of competition between grades. Most paper milk bottles do not require a conventional cap or hood as does the common glass bottle, so as the paper bottle grows in acceptance, down goes the paper cap and hood consumption.

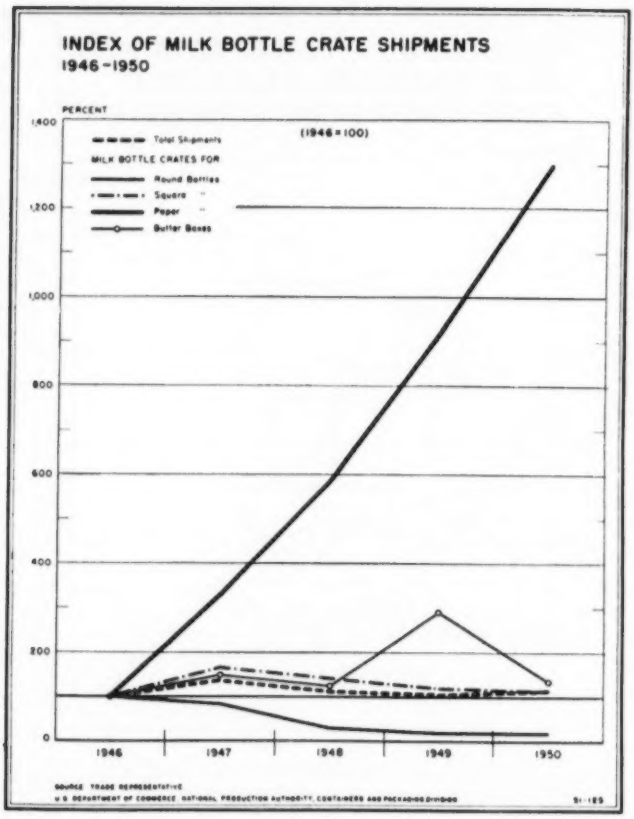
Why a Paper Product

The reason why paper products are chosen would fill many volumes on each of the many items. However it is important that we begin to think in terms of people, for the whole chain of distribution is a chain of people, each with his or her likes and dislikes, whims, and different personal traits.

To get in the proper frame of mind, we have to assume several roles. First that of the manufacturer. I want to package a product. How? What do I want? The first approach must be not what does the manufacturer want, but most important is, what does the consumer want? What kind of a package will make the consumer choose my product above all others, is really the question. No one knows all the answers, but those who do find one or two, through research and good judgment, are well on their way to successfull sales volume. It is not by accident that the leading brands of cigarettes are sold in packages with white the predominating color. Cigarettes cannot be successfully sold in packs looking like a crazy quilt or a circus carnival. People want a neat conservative package.

This is an example of "you must make an attractive package." It may


PRODUCTION OF PAPER MILK BOTTLE STOCK COMPARED WITH CONSUMPTION OF MILK IN CITIES AND VILLAGES 1944-1951
1944=100
PAPER MILK BOTTLE STOCK
MILK CONSUMPTION



vary from conservative to bizarre, depending on the product. But first it must be in keeping with what the customer wants. The other considerations are of course, ease of filling, storing, protection of contents, cost and a host of other considerations.

There are limits of course in costs, especially from a protection standpoint. Consider a package to hold phonograph records. A package could be designed which would protect against any breakage whatsoever. However there is a break-even point to be considered. The package might be designed to protect against 95 per cent of breakage hazards—the shipper standing a 5 per cent loss. The perfect package might cost many times the probable 5 percent loss, thus is not a practical package.

On the other hand there are many products sold where the container cost is greater than the product therein. This condition is common in the cosmetic trade. No woman would buy nail polish in a small tin can like paint. She demands a dainty package and is willing to pay for it.

Retail Distribution

Now let us assume that we are a retail distributor of paper products. We are interested in quality at a price. We, of course, are interested in national advertising carried on by the manufacturer, and we are primarily interested in a turnover of the money we have invested in paper products and, of course, mark-up. It might interest you to know that the average mark-up on food items in a chain super market is about 15 per cent, a rather narrow margin upon which to make a profit. The chain store is looking for reinforcement items, and paper products are just that. The mark-up is probably double that of food.

The promotion of paper products sales is a valuable piece of business for the store. This type of retail outlet is reported as selling 70 percent of all personal and household paper items distributed in the U.S.A. These products are sold by "on-the-spot" suggestion. It is my belief that the homemakers rarely add paper products to their shopping lists. More often the purchase of towels, napkins, toilet tissue, plates, cups, spoons, sandwich bags, garbage bags, facial tissues, dusters are suggested by attractive display.

The display should stop our buyer in her tracks and make her think, "Oh! I am nearly out of napkins and so forth." When it does, the cash register will ring.

Where does the live-wire store manager put the paper products display? As near the cashier as possible, facing the waiting line so that she will buy just before she enters the line. What is there? Most of the household line! Cups suggest plates, napkins, and so it goes. You may ask why it is not the first group of items as you enter the gate. Generally the housewife goes into a market with some definite group of items in mind. Meat, frozen food, beans, etc. She will head for the item uppermost in her mind. And don't try to change her at your peril.

Why are all these items used in large volume? The basic reason is that we are a nation devoted to labor-saving and high standards of hygiene.

The American housewife has been educated from wash tub to the automatic washer. Concurrently, she has been sold on the ease and cleanliness of using a paper handkerchief, a paper towl or napkin once and then throwing it away. And so it follows with the whole product line.

Another example is the rapidly growing home-freezer market. Many homes have eliminated canning and are quick-freezing all manner of food. While there is more to freezer food preparation than just dumping the food into a paper box, or cup, the process is quicker, more comfortable. The packaging items weigh less and it is cooler work on a hot summer day. Paper products head the list as preferred materials, supplanting the glass

jar. It is expected that home freezers will grow from 3½ million now in use to 10 million by 1957.

And so it goes down a long line of retail products. The package sells your quality product, inexpensively, conveniently, and preserves its freshness to promote your customers' goodwill.

Let's assume for a moment we are owners of a soda shop or snack bar. Will it be paper or glass service. Probably paper for its many advantages: less capital cost, no breakage loss, no washing, less labor and, above all, our customers know that no one else has ever used the paper product and their health is not dependent upon the excellence of the dish-washer, as carefully supervised as they may be.

The costs are all in favor of paper but it also has been found by engineering studies that the counter man can serve more customers per hour than with other types of service.

This seems incredible to you, but most large food producers have retail display specialists working closely with the large chain outlets. They require their route salesmen to take courses in display techniques—all to make the housewife reach for their product in preference to any other, the key to their success.

Quality Imperative

We must also be well aware that America's purchasing agent is a quality buyer and we dare not use the package to cover low quality merchandise. She may be sold by the package once, but if the quality is not there, never again.

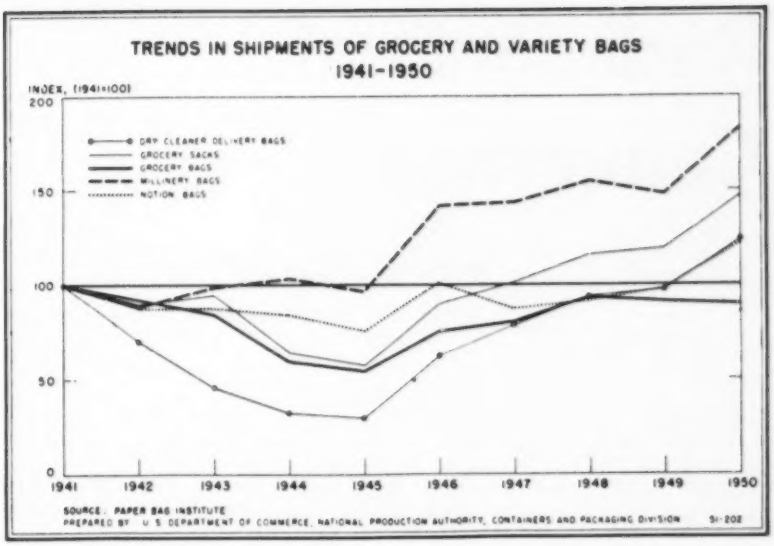
As a good example, a neighbor of mine came home with a package of potatoes. In the bottom of the bag was a large round rock. In the same group of purchases was a bag of oranges; two out of the dozen were rotten. The store manager nearly got the rock delivered through his store window. You may rest assured that once bitten, twice shy of prepackaged food from that store.

The same quality factors apply to paper products such as towels, napkins, cups and plates. The housewife does not need a quality control department to tell her that the wet strength resin was left out of the beater on a lot of towels. She will change brands if the towel goes to pieces in her hands.

In my own house, I get a quick report on paper products quality. There are certain brands accepted in my household—other brands are taboo because at some time they dropped their quality or have never attempted to make it.

Pricing

We have another problem which always bears watching. That is price.



Our people have been educated to regard household and personal paper products as inexpensive throw-away items to be used in the most liberal sense. One towel is ample to dry your hands, but watch and see how many people take two, without regard of cost because it is so little.

With increasing raw material and manufacturing costs plus sky rocketing taxes, we can out-price ourselves and seriously impede our upward progress.

We have had numerous reports from Europe during the past 2 years of how the cost of paper had reached such high levels that packaging had to be eliminated or greatly curtailed.

Of the Future

It is not well that we should dwell in the past and its great achievements in developing the acceptance of paper and its products. Where do we go from here? That is the important question. Many signs point upward in keeping with the past well established trends, and it is required of us to watch these signs and correctly interpret them.

First, the super market. Self service sales technique is causing a distribution revolution and is taking a definite hold in lines other than food. One of the largest department stores in the world is building over, as a fore runner, its whole linen department into a self service unit.

This trend cannot be stopped, and as it expands into clothing and other items, packaging will benefit. This revolution will make all manner of demands for better papers, boards and packages, probably not even dreamed of at the present time.

In the well established self service lines like meat, while the growth has been tremendous, there are still over 50 per cent of the stores which have not been converted. The pre-cooked prepackaged meal is still in its infancy. In Albany a few weeks ago, I was amazed to see the number of people buying cooked fish dinners, hot from the kettles, placed on paper plates, put inside of bags, to be carried home for consumption. A growing form of new business. In-factory feeding is still growing with greater selection of foods.

The automatic vending machine using cups seems bound to increase. The advantages of no bottles to pick up, wash and refill are obvious. Imagine if all the time used in plants and offices to get the extra 11 o'clock cup of coffee was added to the productive effort by the use of hot coffee machines conveniently located. The demand for cups would sizeably increase.

No one would look to the New York subway system as a snack bar but they experimented with automatic vending machines with some misgiving. During 1949, 128 machines sold a gross of $714,796 in drinks. 111 machines averaged $31.54 a day in August 1949. That's 630 paper cups per day per machine.

New materials for coating, impregnating and treating paper are constantly being introduced. New fabricating methods are developing. All directed to better quality, low-cost improved paper products.

The limit depends only upon our ability to use these ideas and materials to create more profitable markets. As young men just entering the paper field, the world is yours to do with it as you wish.

Rudiments of Converting

Martin J. Galbraith
Sutherland Paper Co.

A discussion of the "Rudiments of Converting" is a difficult subject due to its broad aspects. Surely to an audience such as this, made up of people who have devoted a portion of their lives to the theoretical and practical aspects of the manufacture of paper, and of students who have completed nearly four years of study in the same field, it must be apparent that a single lecture on "The Rudiments of Paper Converting" would of necessity be sketchy. When we remember that the finished product of paper manufacture is only one of the raw materials for the paper converter, the vast scope of the field of converting becomes apparent, particularly since most paper or paperboard passes through more than one converting operation before it reaches the consumer. This lecture would be quite presumptuous if it were to attempt more than a bare outline of the important operations performed in converting paper and paperboard.

If we want to look at the history of the converting industry, we may go as far back as Ts'ai Lun, the proverbial first papermaker. Undoubtedly his first sheet of paper was hardly couched from his primitive sheet mold before some long wiskered oriental whipped out a paint brush and became the first paper converter by stroking a few choice Chinese characters onto the sheet. Since that day almost every sheet of paper made by any means has been converted in some way or other to supply functions that could not be "built into" the paper on the paper machine. In short, the converter adds to the value and utility of his raw material, paper or paperboard, by printing it, cutting it to size and shape, forming it, or by combining it with other materials.

Converting may be simple. It may be as simple as winding a sheet of kraft wrapping paper into a small roll convenient for wrapping merchandise, or ream cutting sheets of paperboard to size for the simplest type of shirtboard. Converting, on the other hand, may be as complicated as printing in five colors, laminating with a transparent sheet, embossing, infolding or binding into a luxury book. In the converting industry, paper, paperboard, resins, glues, films, inks, waxes and many other materials are combined to form an almost unlimited host of cheap and useful products. The converters are the magicians who turn the millions of tons of paper and paperboard produced in this country into a horde of miraculous products, ranging from a dollar bill to the magic box that replaced the clerk in the supermarket.

This lecture has been prepared to form an outline of the major operations normally used by paper converters in adding to the value and usefulness of paper and paperboard. Since a large portion of the paper or paperboard produced is printed, and this form of converting involves the largest investment in equipment and skilled help in the converting field, we will discuss the fields of printing, printing proceses, printing machinery, and printing inks. We will also outline equipment and materials for cutting, scoring, stripping, and gluing. In addition, we will cover adhesives, laminating, waxing, forming, and application of protective, decorative and functional coatings.

Printing

Reliable estimates state that between 80 and 90 per cent of the paper and paperboard produced in this country is printed in some form before it reaches the hands of the consumer. Even if these estimates were high, printing is certainly so intimately associated with paper in our economy and our thinking that it may undoubtedly be given first place in any summary of converting operations.

The general term "printing" covers a multitude of processes for applying a contrasting color, or series of colors, to a sheet so that a given pattern may be reproduced. The color, or ink, applied may be one of many types of chemical compositions, and the surface to be printed may be almost any conceivable type of paper or paper product. In fact, the printed surface need not be paper. Although the vast majority of the printing presses in the country do most of their work on paper, millions of impressions are made daily on such surfaces as metal drums, foils, transparent films, opaque plastic sheets, textiles, and even eggs. The press itself may vary in size from a small greeting card press hardly larger than a typewriter to giants in the publication field larger than many small paper machines.

Printing processes are generally divided into four main categories, each process defined by the basic characteristics of the printing plate, or ink transfer surface. *Typographic processes,* as shown in *Figure 1,* are those in which raised portions of a plate contact the ink and transfer it in turn to the paper. *Typographic printing* by the letterpress process accounts for the major volume in the graphic arts field. Other typographic processes include flexographic printing, relief printing, die stamping and, in a sense, the common typewriter. *Planographic printing,* shown by *Figure 2,* is a method of transferring ink to the paper from a plane surface, treated so that the ink adheres only to the portions where printing is desired. *Lithography or offset printing* is the most prominent representative of this field although other processes such as Multilith, Aquatone, Collotype and Hectograph are also representative of the planographic process. *Intaglio printing* is distinguished by printing from a surface so designed that the ink is in recessed portions of the plate and is literally pulled from the recesses by the paper as shown in *Figure 3.* Engraving and etching are two forms of intaglio printing, but the largest application of the intaglio process is in the gravure field. *Stencil printing,* the fourth in the main classes of printing, involves forcing ink through certain portions of a mask to

print a pattern on a receptive surface. The familiar mimeograph and silk screen processes are representative of this type of printing. *(Figure 4).*

Most of the above processes may be further divided into classes depending on the mechanical arrangement of the machines used in bringing the ink into contact with the paper.

Thus presses are classified as to the number of colors which may be applied in one pass through the press, and we have such terms as "one color presses" or "five color presses." Letterpresses, for instance, are subdivided into platen presses, flatbed presses, and rotary presses by the arrangement of ink distribution systems and plates and

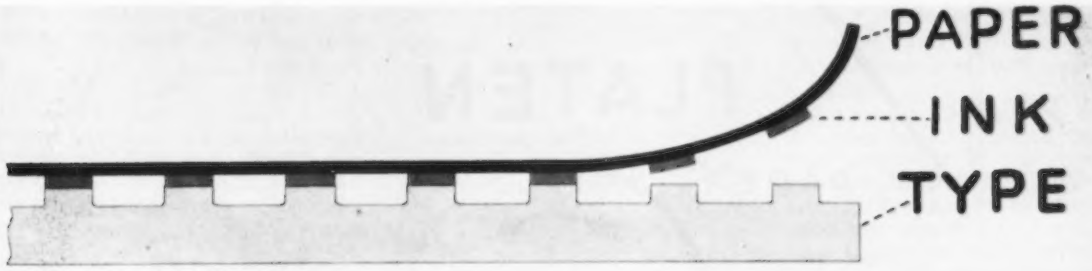


FIG. I TYPOGRAPHIC

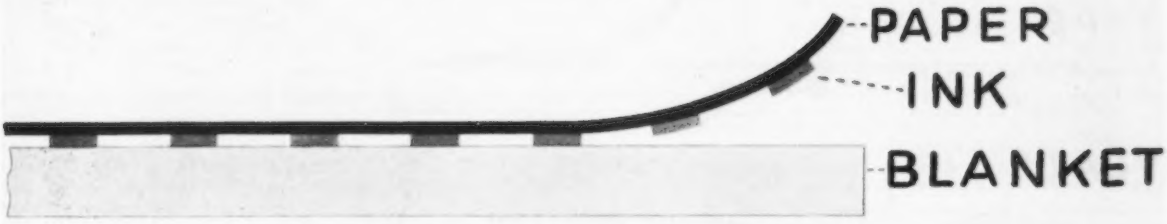


FIG. 2 PLANOGRAPHIC

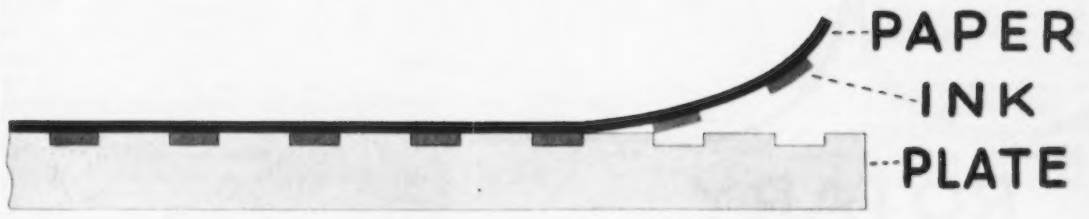


FIG.3 INTAGLIO

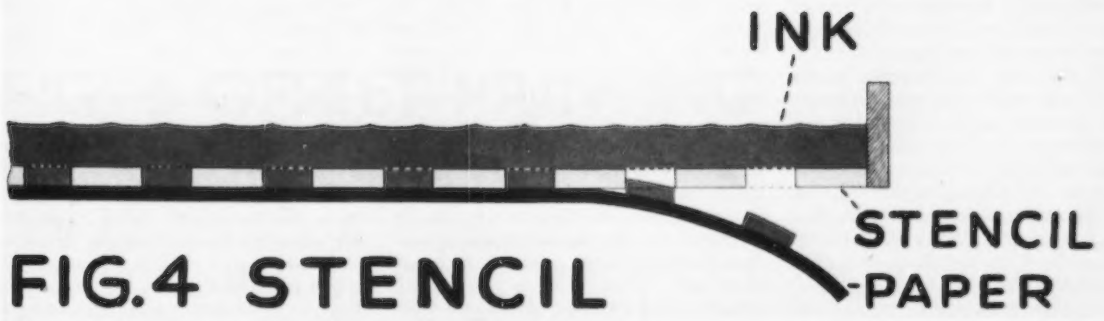


FIG.4 STENCIL

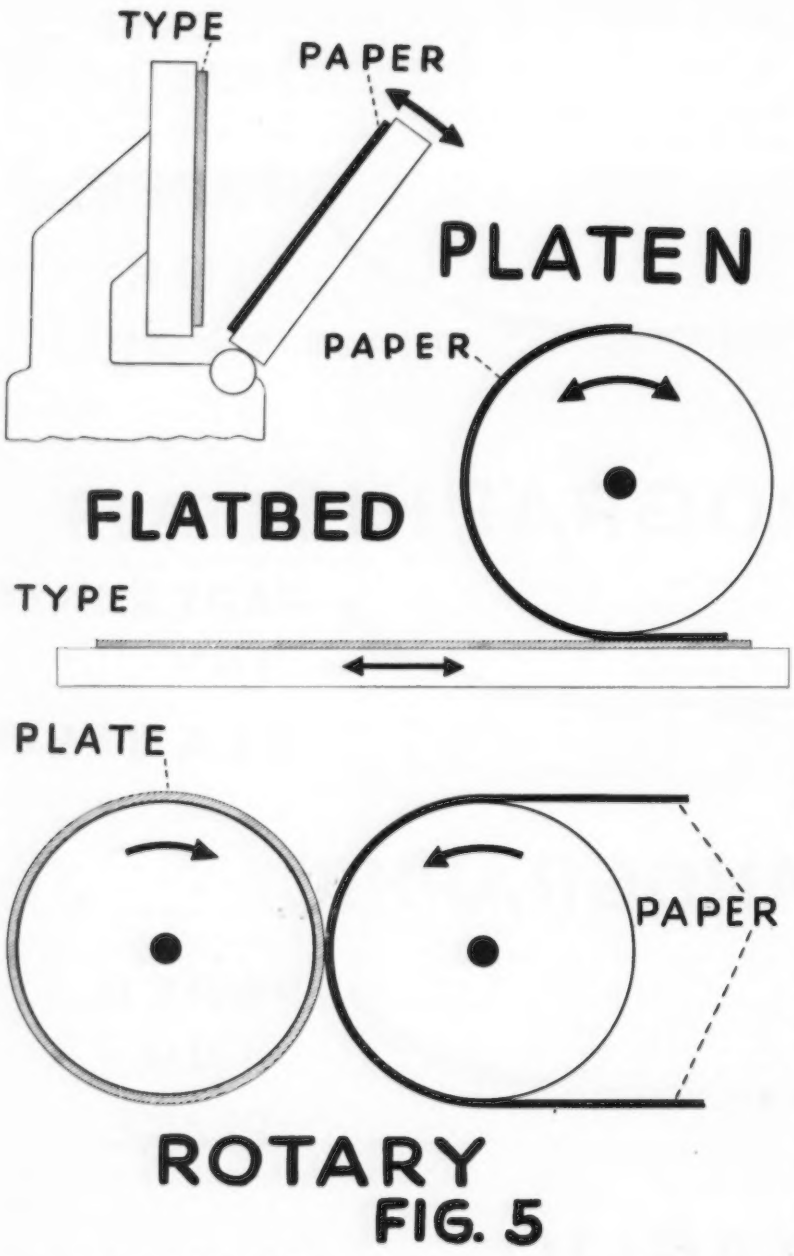


FIG. 5

paper as shown in *Figure 5.* These factors, plus feeding and delivery characteristics, size of sheet, width of web, and size of printing rolls, usually serve to identify printing presses.

Letterpress printing, in one form or another, has been the mainstay of the graphic arts field since the discovery of the printing process in about 450 AD, when it is recorded that the Chinese used inked, engraved seals, similar to the rubber stamps in use today. The installation of efficient new high speed letterpress units has kept this branch of the industry in a state of steady growth.

Letterpress printing is one of the typographic processes, in which ink is transferred from a fountain, or reservoir, to a series of distribution rollers. This distribution system serves to spread the ink uniformly so that an even film may be applied to the raised portions of the printing plate and then transferred to the printing surface.

The raised surface for the letterpress process may consist of type, set by hand or machine, and locked in a form for printing relatively small numbers of units. Illustrations are usually prepared by the photoengraving process, also used to reproduce "type copy" from typewritten or hand lettered originals, without the use of hand or machine set type. For the reproduction of orders running into hundreds of thousands of units, the original photoengravings or locked type forms are not used directly, but are used to reproduce duplicate printing plates by either the stereotype or electrotype process. In this way several identical sets of plates may be prepared, all more durable than the original.

The letterpress process is characterized by unusually sharp impressions, particularly in line work and written copy. Clean, sharp, multicolor process work with letterpress is obtained when the paper or paperboard possesses the proper smoothness and compressibility characteristics.

Offset printing, often referred to as lithography, is a process second only to letterpress printing. The process stems from true lithography, credited to Senefelder in Munich, Germany, in 1798. In lithography, a special porous limestone is treated so that portions of the stone repel water while the untreated surface absorbs water. In printing, the stone is wet with water, and then inked, with the ink adhering only to those portions of the stone originally made water repellent.

Offset printing is an indirect planographic process similar to lithography. In this process, a sensitized metal plate is etched to have ink receptive and water receptive areas. This roll rotates against three other rolls; the first in the sequence a water or "etch" roll, the next an ink roll, and finally the offset roll, also called the rubber blanket. The ink is thus transferred to the plate, from the plate to the blanket, and from the blanket to the sheet. This transfer from a plane, flexible surface, allows the use of extremely fine halftone dots on relatively rough paper surfaces. *(Figure 6.)*

The property of printing on rough surfaces or on unyielding metal surfaces is one suggesting some of the uses of this process. Exceptional reproduction of delicate colors is also characteristic of this process, particularly when softness in color graduation is desired. Offset printing is sometimes susceptible to color variation, and register troubles are rather frequent.

Gravure printing is the third process in wide use today. Although "sheet-fed" gravure is used for cerain fine color reproductions, rotogravure accounts for the major volume in this field. This is an intaglio process, depending on transfer of a fluid ink from recesses etched in a cylinder. The cylinder is etched with holes of uniform diameter and tonal variations are obtained by varying the depth of the holes.

Ink is applied to the etched cylinder from a pick-up roll, and the excess is

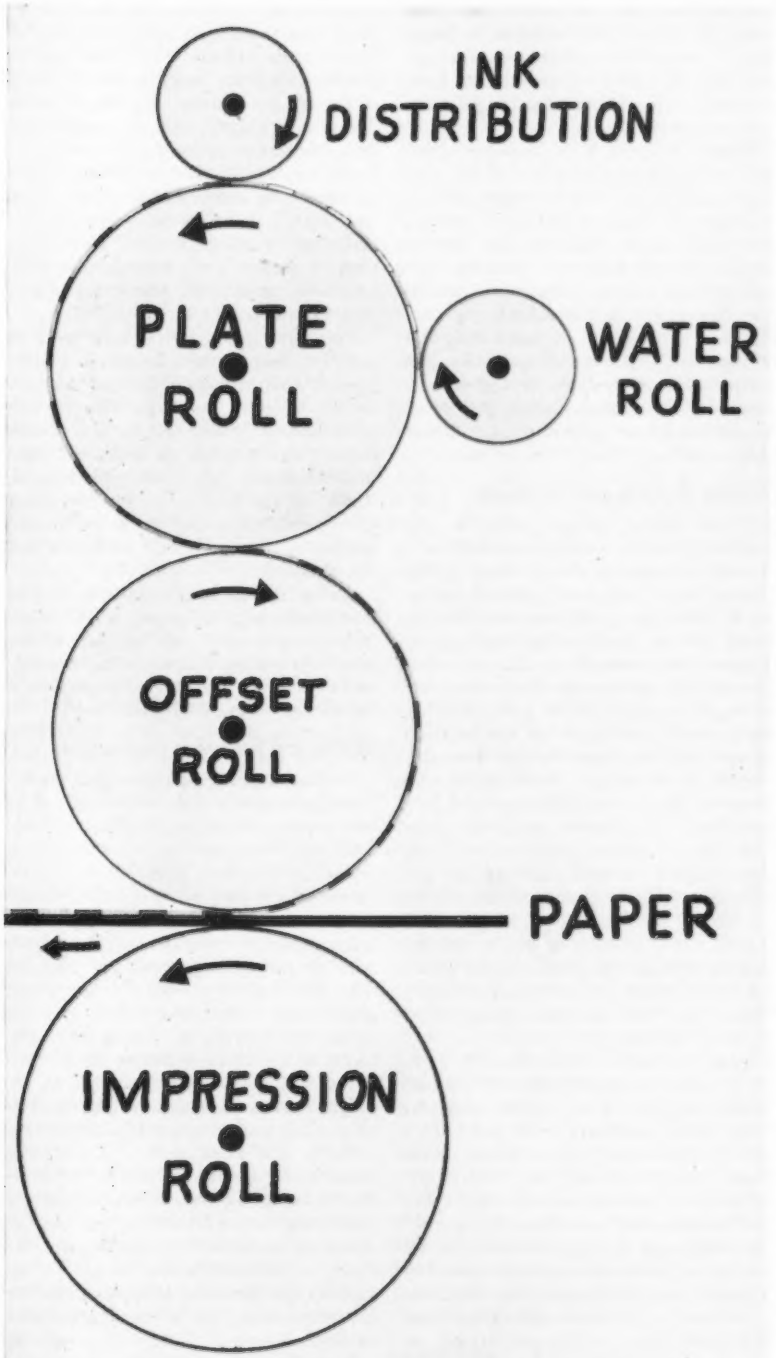


FIG. 6 OFFSET PRINTING

removed by a doctor blade, leaving only the ink in the cavities to be absorbed when the sheet is pressed against the cylinder. Inks for this process are solvent systems, permitting almost instantaneous drying.

While fine detail, and excellent tone graduations are possible with this process, the high cost of etched cylinders limits the process to extremely long press runs. Printing by this process is usually recognized by the lack of an impressed pattern and the delicately serrated edges of type or line portions of the print.

Flexographic printing is one of the modifications of the typographic process. This method involves the printing with solvent-type ink from the raised surfaces of a rubber plate. In the original process, aniline dyes in alcohol solution were used and the process was called aniline printing. Modifications in the original ink made the choice of a new name for this process the object of national graphic arts balloting.

At present, flexographic printing covers the use of systems in many solvents other than alcohols, including water and various ethers, ketones, and esters. Resinous binders are also added and pigments are used in the inks, making the line between flexographic printing and conventional letterpress operation indistinct.

Flexographic printing is used where a simple press is desirable since makeready time is cut to an absolute minimum and changeover from one job to another is relatively simple. The process is used a great deal in the printing of films where rapid drying by evaporation of a solvent is important. It is of increasing importance for short runs.

Silk screen reproduction has increased tremendously in recent years with the development of automatic silk screen presses in place of the hand operation long considered essential for silk screen work. The process involves forcing ink through a stencil over a sheet of silk cloth, through which the ink is squeezed by a flexible blade.

Most silk screen work at present is in the textile field or is used in display advertising. Silk screening is adaptable to objects of irregular shape, and is also used in printing labels directly onto bottles, cans and jars. The process has growing uses where heavy, opaque films are required for special effects.

Ink

Printing presses, of course, are useless without inks. The making of inks specifically designed to work well on the various presses, and to meet the requirements of additional converting operations is in itself a large industry. Inks consist of a pigment or dye selected to meet permanence and color specifications, plus a binder to hold the color to the sheet, and a vehicle to carry the pigment and dissolve the binder. These ingredients are blended to suit the flow properties necessary for satisfactory press operation on the stock and equipment to be used. The selection of ink also includes many considerations related to the service planned for the printed sheet. High rub resistance, product resistance for packages, resistance to water, and

countless other special requirements must be kept in mind by the ink maker.

Many approaches have been used in an attempt to formulate an "Ideal" ink. Such an ink would be a compound easily adjusted to a wide range of flow properties and viscosities to fit all recorded printing processes, and compatible with a broad range of pigments and dyes. This ink should stay fluid on the press and in ink fountains without changing in any way with time or work expended on it. It should function well over a wide range of temperatures and humidities and should be easily adjusted to give various degrees of gloss and "flatness" in the dried film. Finally, this ink should react instantly with paper to form a well bonded, insoluble, rub resistant coating of uniform thickness free from tack, transfer, strikethrough, and odor.

Most of the work designed to produce these highly desirable features has centered on methods of drying the ink. In general the methods fall into one or more of the following classes:

1. Oxidation or reaction of the oil vehicle with air.
2. Polymerization or chemical interaction.
3. Penetration or soaking in.
4. Precipitation or deposition of solids from a solution.
5. Evaporation or loss of solvent.
6. Chilling of a hot melt application.

Conventional oil inks are usually considered as drying by oxidation of the unsaturated oils used as the vehicle, although some polymerization undoubtedly takes place. Some of the resinous dispersions dry almost entirely by polymerization. The penetration process is represented by the tremendous tonnage of inks used annually on newspapers. The precipitation process is used commercially in moisture setting inks and is the subject of concentrated research at present. High speed web-fed publication presses consume large volumes of solvent drying inks. Chilling types have been tried but are not extensively used as present.

The bulk of letterpress and lithographic ink is compounded of organic or inorganic pigments dispersed in an oil that will dry by oxidation and polymerization to form a hard, insoluble, binding film. Many formulations in actual use are a blend of several pigments often including transparent pigments used to extend and "body up" the mixture. Most of the oil used in this process is modified linseed oil, which, in the case of a simple ink, serves as both vehicle and binder. In addition resinous binders, oil extenders, catalytic drying agents, stabilizers and waxes, may be included in the compounding. The final mixture, checked for color and other characteristics, is thoroughly blended in large mixers, and is then dispersed on a colloid mill, usually a three roll ink mill, although various specialized high-shear mills are now in use.

Many letterpress publication inks and most gravure inks are of the solvent drying type, where drying at temperatures as high as 1200° F. allows the high speeds required for weekly production of magazine running into millions of issues. Moisture setting inks, wherein a resinous binder is precipitated from a glycol soluton by the addition of an excess of moisture, are widely used where rapid drying of conventional letterpress printing is needed, or where a low odor-level is important.

Cutting, Scoring, and Stripping

These operations are generally encountered in the folding carton industry where complex shapes must be cut from roll or sheet stock, and where the stock must be weakened for folding along specific lines so that rigid three-dimensional forms can be produced from the sheet material. In these processes dies made from steel cutting knives and creasing strips are used on presses similar to many of thoe employed in printing. In this process sharp knives are arranged to cut a pattern in the paperboard used as a raw material. On the same male form, steel "rules" are laid out to score the paperboard in those places that are to be folded in the final product. The female die is usually made by gluing a compressible sheet to the steel backing roll or plate and trimming or "running it in" with the male die selected or made for the job.

Requirements for these dies are quite rigid, since they must withstand a great many impressions and must maintain dimensional accuracy and must frequently maintain close register with printed designs already in place on the board to be converted. Flatbed dies are the commonest in the folding carton field, and have replaced most of the platen presses previously used for both printing and die cutting. Recently, demand for greater speed, and for operations that can be performed on one integrated machine, has led to the use of reciprocating and rotary die cutting units. In all these processes, the cutting knives are nicked at intervals so that the sheet will not have a continuous cut and will not fall apart before delivery at the end of the press or before "stripping" operations.

After die cutting, the trim or waste must be removed from the portions of the sheet that are to form the final product. Much of this removal or "stripping" as it is called in the industry, is done by hand. In hand stripping, men use hammers to strike the waste from six to eight inch stacks, tearing the trim away from the body of the die cut articles. In many plants, this hand stripping is being supplanted by pneumatic stripping where men guide pneumatic chisels through piles of sheets to remove the waste. For small cut-outs or for fine detail, pneumatic or hydraulic presses with automatic positioning devices and specially designed rams and punch-out plates may be used.

Fully automatic stripping is now in practice for certain long-run operations. This stripping is done on specially designed units on the cutting press or in line with it. In these processes, vacuum grips or barbs are used to hold waste portions on a cylinder while the cut blanks are carried away by a tape system, and the scrap is subsequently released over a conveyor belt for disposal.

These operations are not confined to the converting of paperboard, since they are also used with lightweight papers whenever special forms are required and, in some cases, are used with lightweight metals or plastics.

Gluing and Fastening Operations

The converting of paper and paperboard often requires the fastening of two or more component parts to produce one whole product. Furthermore, segments of one part may require fastening to other segments of the same piece as in the case of envelopes, where conversion consists of gluing three parts to form a pocket, with a gummed flap which must close the pocket at some later time. Fastening may be either mechanical, or through the use of an intermediate adhesive layer, usually called gluing or gumming.

Mechanical fastening is encountered in stapled magazines, containers, bags, cartons, and other items. Other mechanical fastenings include sewed pamphlets, books and bags, where paper is held together with thread or twine. Many styles of folding cartons are devised so that interlocking tabs and slots fasten the flat paperboard together in such a way that a box or tray may be formed.

Since many uses devised for paper products require features not obtainable through mechanical joining, extensive use of adhesives is made in the converting industries. Since two paper surfaces do not normally adhere to each other, an intermediate substance which will adhere to both of the surfaces is used to effect this fastening. The adhesive or "glue" may be any one of a wide variety of compounds or mixtures. Choice of the particular adhesive to be used depends on the na-

ture of the two surfaces involved, as well as the cohesive bond of the glue itself. Other requirements may be dictated by the service to be expected from the fastened joint when it has been completed. In some cases water resistance must be obtained, or resistance to oils, fats or certain gases may be required of the bond. The speed with which the adhesive "sets" or forms an effective bond, is often the deciding factor in the selection of the proper adhesive. The gluing machine to be used may dictate certain adhesive requirements of viscosity, "body", stability or foaming characteristics. The use of the glued product may require freedom from odor or possible toxic effects. For certain items, the adhesive must retain bonding properties at freezing temperatures, or in the presence of boiling liquids. The storage conditions and required shelf life of the glued item may limit the choice of adhesive.

Many classes of adhesive are used today, ranging from sodium silicate or "water glass" to complex synthetic organic resins. One of the simplest classes of adhesive in general use in the paper industry is made up of a starch base. Dextrines are made from starches, roasted to break down the structure of the complex molecules so that partial or complete water solubility is obtained. Other starch based adhesives include acid-hydrolyzed, oxidized, enzyme-converted, alkali-gelled, and chemically modified starches. These adhesives are popular because of their relatively low price and because they may be put into solution easily. High gel strength may be developed for quick tack and rapid setting. The addition of various plasticizers, preservatives, and modifying ingredients can do much to overcome some of the natural disadvantages of these adhesives. Borax and alkali are the commonest modifying ingredients used with starches.

Animal glues, including bone and hide glues, are also widely used. These adhesives are characterized by their ability to change from a fluid state to a firm jelly after a minor drop in temperature, making possible gluing at extremely high speed by utilizing this temporary bond which soon becomes permanent due to the loss of water from the adhesive. Here, again, compounding with various additives extends the usefulness of this class.

Other protein adhesives such as casein, zein and soybean protein, find limited application in joining paper in converting operations, although their major use in the paper industries lies in the coating field.

Relatively recent developments in the field of synthetic resin adhesives have done much to improve the uniformity and dependability of special purpose formulations for the specialty converting fields. The use of thermosetting and thermoplastic resinous dispersions and solutions has done much to extend the uses to which adhesives may be put and to speed up operations in converting. Of the synthetic resins, mention must be made of the various polyvinyl formulations, both the acetates and the alcohols. These rubbery, thermoplastic polymers have a very high early tack, and have been used successfully on many of the newer gluing machines where high speed operations are necessary. These adhesives are also useful on waxed or coated surfaces, formerly almost impossible to glue. The dispersions develop a strong initial set when the emulsion is broken by pressure, and form an extremely deep bond when water evaporation completes the drying.

Natural gums, natural and synthetic rubber, lacquers, and pastes made from various cereal grains also have limited applications in the converting field. Hot melt adhesives, such as asphalt and microcrystalline wax, are particularly important in the laminating operations to be discussed later in this paper.

Machinery for applying these adhesives and for effecting the final bond may range from the simplicity of a glue pot and paint brush, to complicated machines capable of applying spots of adhesive to carton blanks and finishing firmly bonded cartons at speeds in excess of 40,000 units per hour. These machines deliver the cartons to belts and literally print them with strips or spots of adhesive after preliminary folding. The cartons are further folded and the glued seams are pressed together before delivery to a set of pressure belts where the final "set" of the adhesive takes place.

As further lectures on converting are presented, the true importance of adhesives in the converting of paper and paperboard will become obvious. Although no reliable figures are available, it is not unrealistic to assume that at least half the paper and paperboard produced annually is converted in some way or other through direct or indirect use of adhesives.

Lamination

Laminating is the process of combining two or more plies of material into a single sheet by means of a laminant or adhesive. In this way combinations of materials can be made which may possess increased strength, improved appearance, greater utility or better functional properties.

The choice of ply material and adhesive depends entirely on the requirements of the finished product. One ply may be selected for its rigidity, strength, printability and appearance, while a second ply may be chosen because of its properties of greaseproofness and opacity. The adhesive or laminant must bond the two surfaces; however, it may also contribute certain functional values such as water resistance or a favorable moisture vapor transmission rate. It is important that the adhesive used retain its bond under conditions that the finished lamination will face in storage and use.

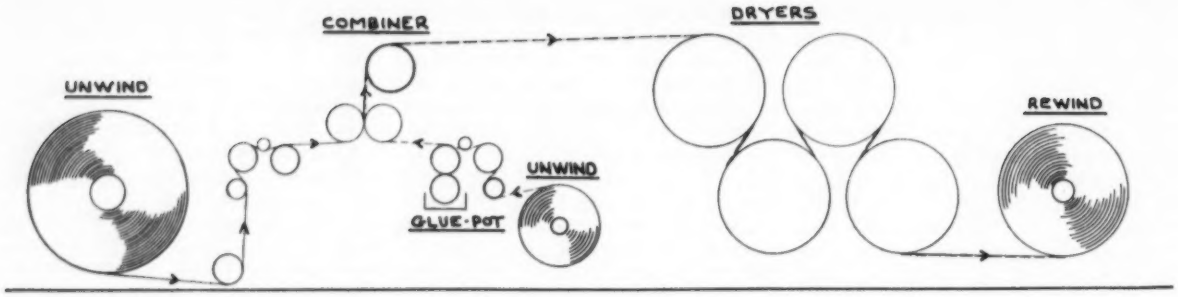
Many grades of paper and paperboard are used for laminating. Various printing and folding grades of paper and paperboard are laminated with greaseproof or glassine sheets or with grease resistent films to extend the versatility of the paper. Conversely, the board or paper may serve as a relatively strong support for weak films or foils. Almost any plane, flexible material may be incorporated in a laminate, including cloth, plastic films, and metal foils.

Any of the adhesive types previously mentioned in our discussion of gluing operations may be used in laminating, although adhesive cost is a much more important consideration in the laminating process. Hot melt adhesives such as microcrystalline, paraffin wax, and bitumen or asphalt find their major use in the laminating field.

The types of equipment used for laminating may accommodate two or more plies. Two-ply lamination is the most widely used. It must be mentioned that as the number of plies increase, certain disadvantages may become apparent. Each additional layer increases the cost of the product and usually results in increased rigidity and poor working properties. More complicated equipment is required, adhesive limitations are encountered and dimensional instability frequently increases.

Laminating processes can be divided into three general types, the first of which is the hot melt type. In this process, a hot melt adhesive such as microcrystalline wax or asphalt is used. The second type includes machine known as pasters, using starch, dextrine, casein, or water emulsion resin as an adhesive. The third general class is that of resin impregnate laminates. These are made in a batch process by saturating the desired number of plies with a thermosetting resin and then bonding the laminate at high temperature under heavy mechanical pressure.

Some extremely complex laminators are now in use, but the most complicated of these devices is based on the simple principles of an elementary two roll laminator. In a simple laminator, the adhesive is applied to the surface of the less absorbent sheet and this sticky face is pressed against the other sheet in a nip between two rolls. In



LAMINATOR
FIG. 7

hot melt application, the sheet is then cooled to set the adhesive; pasted laminates are dried on steam heated drums. The laminate is then rewound or cut into sheets. *Figure 7* illustrates a two ply laminator.

The adhesive may be applied by almost any coating machinery adapted to the adhesive used or suitable for the operating speeds desired. Roll coating heads or roll coaters with doctors to control film thickness predominate.

Provisions for high speed, accurate tension control, and versatility add to the complexity of laminators. Solvent removal systems and sheet guides may be incorporated in laminator design.

Paper Coating

A coating operation is the covering of an object by some fluid material to produce a change in surface properties. The idea of increasing the utility of paper through coating is not a new one. In fact, the origins of paper coating are lost in the early history of papermaking since glues, gelatine and various cereal pastes were used as coatings before the art of papermaking ceased to be an oriental secret.

A change in the surface properties of paper or paperboard may be required for one or more of the following reasons:

1. To change appearance, gloss, or color.
2. To change smoothness, hardness, abrasion resistance.
3. To improve printing characteristics.
4. To incorporate resistance to food items—particularly grease resistance, or chemicals in general.
5. To alter gas and vapor permeability.
6. To improve the durability of the product toward insects, mold, bacteria and rodents.

These surface changes may be produced by one or more of a group of coating materials. The ideal coating should possess several characteristics in addition to the surface properties sought. These should include freedom from toxicity, odor and blocking tendencies, along with good stability, price, and ease of application.

The wide variety of materials which are available for paper coating may be grouped somewhat arbitrarily, based on the nature of the material or the purpose to be accomplished. Three specific types which appeared early in the history of paper coating are printing, waxing and clay coating. Printing actually is a type of coating and in some instances the distinction between the two disappears, as is illustrated by over-print varnishing. Paraffin waxing, which has developed within the past sixty or seventy years, has grown to include a large percentage of coated papers.

The so-called "clay-coating" of paper is an important modification which has developed into a specific technology, blending quite closely with the paper manufacturing operation, and frequently not considered a converting operation. It has provided a relatively low cost method for improving appearance and printing characteristics of paper and paperboard.

The newer types of paper coatings have developed largely to meet the increased demand for changes in the functional properties of the surface of paper and paperboard. These coatings have been made possible largely through the results of developments in the synthetic chemical industry. While these applications have been introduced during the past three decades, progress has been greatest during the last ten years.

It is convenient to simplify our discussion by classifying coatings into three major systems, namely, *solution*, *dispersion* and *melt*. However, specific coatings exist which cannot be clearly classified by this simplified method.

A *solution* type of coating comprises a generally true solution of film forming material in non-film forming liquids. The liquids serve the purpose of permitting and facilitating the application of the coating material in film form. Lacquers and varnishes as well as some water dissolved materials belong in this group. Nitrocellulose lacquers, which enter into many different industries, are some of the best known examples of solution coatings. The solution system provides ease of application with simple compounding and rapid drying. Very thin films may be applied by this method and certain materials can be applied only by solvent techniques. Disadvantages of the solution systems include low solution solids, necessity for complex solvent recovery, or the loss of the expensive solvent, plus the safety hazards usually associated with organic solvents.

Dispersion systems include coating materials which actually differ from each other quite extensively with respect to composition and resulting film properties. However, they all possess the common qualification of being colloidal dispersions of the film forming components and follow a different viscosity behavior when compared with solution systems. They include clay coatings, (not covered in this discussion), latex types, plastisols and organosols. In addition it should be noted that a solution coating may be converted to a dispersion type by emulsification. Dispersion types include such advantages as high solids at the coater, the use of film formers which are not readily soluble in liquids, the use of low cost volatile components, and the elimination or drastic reduction in solvent hazards. Dispersion systems are sensitive to heat, freezing and mechanical stress, and at the present time they are limited primarily to thermoplastics. Critical formulating conditions also require a delicate balance of coating system components, thus increasing the problems of technical supervision.

The term "hot melt" is generally applied to the third major group of papercoatings. Hot melts consist of solids which are heated to a molten condition to permit application. Waxes are included as a sub-class in this

COATING METHODS

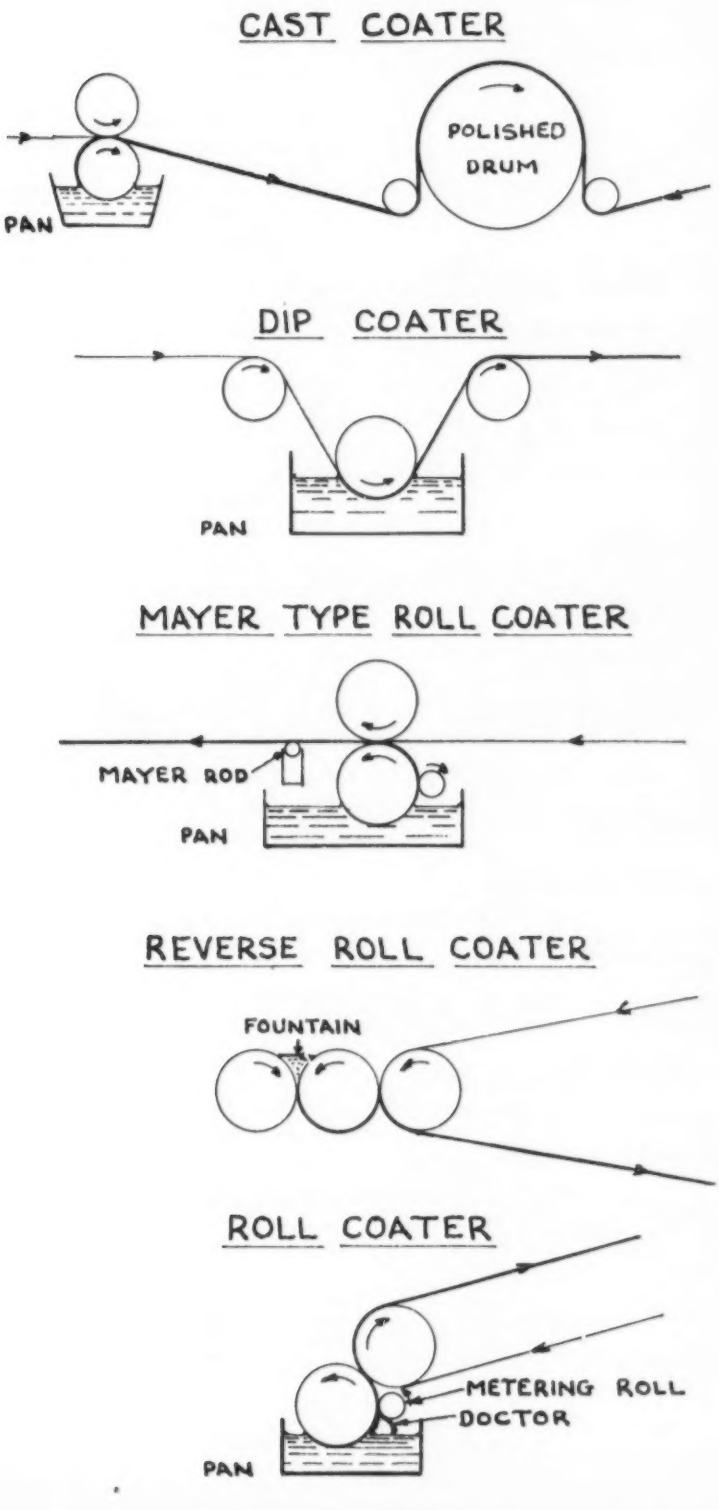


FIG. 8

group and constitute the most important part on a volume basis.

While the term "wax" includes a range of microcrystalline and crystalline substances of rather indefinite melting point and chemical composition, the materials most widely used in paper converting are paraffins and modified paraffins derived chiefly from petroleum sources. These waxes possess an attractive combination of properties which includes ease of application, low cost, good moisture resistance, and some heat sealing properties. This combination has made paraffins particularly desirable for modifying food wraps and food containers.

In paper converting, waxes are used to coat, to saturate and to laminate. A glossy, external wax coating is known as wet waxing or, also, as cold waxing. In this process conditions are selected to apply the wax as a surface coating by chilling in a water bath immediately after the molten wax is applied. In wax saturating, or dry waxing, conditions are selected to drive the wax into the paper or paperboard, leaving a minimum of wax at the surface. Hot waxing refers to another type of treatment of paperboard which is intermediate between wet waxing and dry waxing, wherein a light, low gloss film remains on the surface and a small amount of wax penetrates the stock. In many laminating operations waxes are used as a moisture barrier adhesive to combine sheets of paper or paperboard. In these various applications wax has been criticized chiefly for lack of grease resistance, poor low temperature flexibility, and a tendency toward blocking. To overcome these disadvantages considerable effort has been expended in the modification of paraffin with other waxes and with various synthetic materials.

In addition to these applications, several thermoplastic compounds have been applied to paper in the form of hot melts. Polyethylene is an outstanding example at the present, and other materials may be expected to appear in this field as application technology progresses.

Application techniques have, in fact, often required as much ingenuity as the formulation of the various coating systems. Coatings are applied to paper by roll coaters, knife coaters, air jet coaters, spray coaters and cast coaters. Roll coaters are undoubtedly used more widely than the other types and will accommodate a wide range of materials. For certain materials specific equipment is required, and successful application of some of the coating materials has been possible only as the result of the development of proper equipment. Figures 8, 9 and 10 illustrate various coating processes.

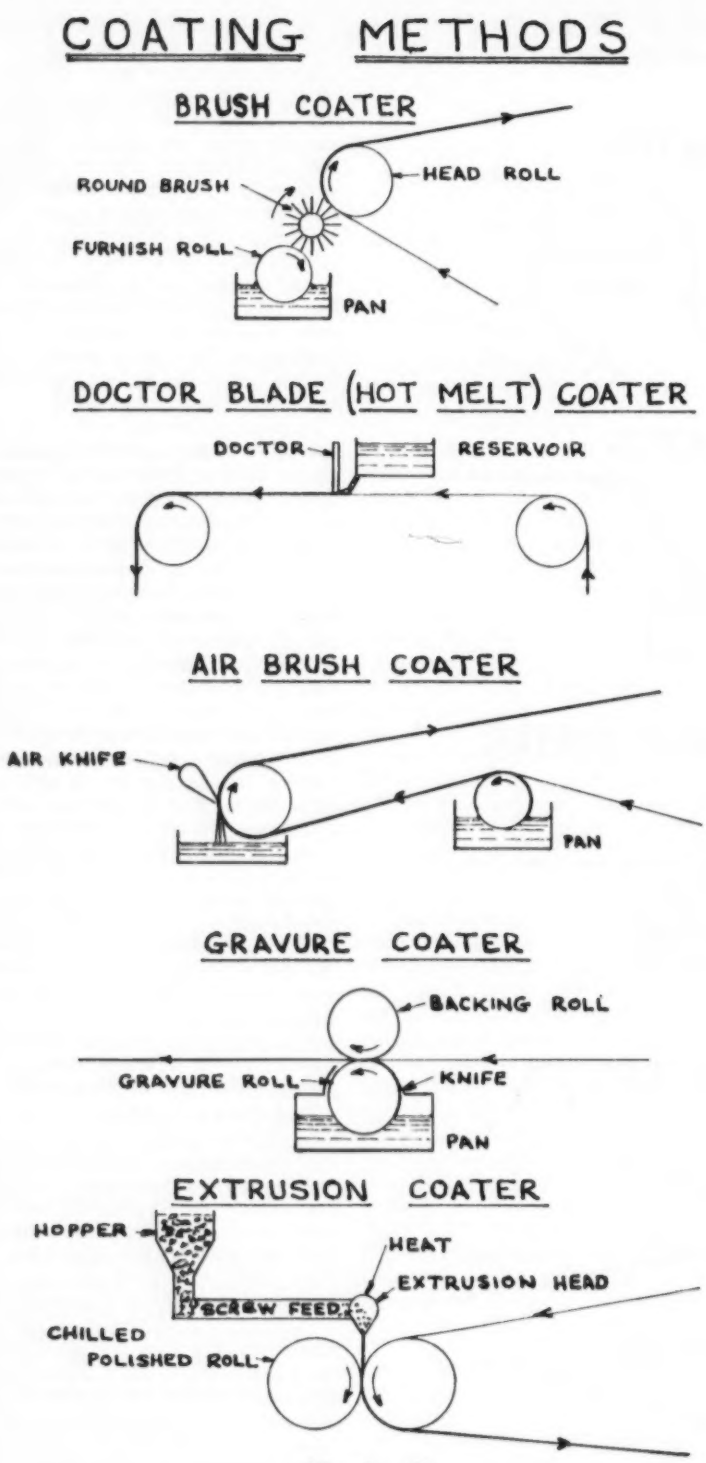


FIG. 9

Paper Forming and Drawing

Many uses for paper require forming operations not covered in earlier sections of this discussion. Most of these operations result in a permanent deformation of the paper. Examples of forming and drawing include twisted fiber cords and threads, paper plates and cups, embossed stock, and many pressed paper toys and decorations. Molded pulp articles are sometimes included in this category, although they are usually formed directly from a pulp slurry, rather than converted from a finished sheet of paper or board.

In twisting, a highly directional sheet is slit into narrow ribbons which are then twisted under tension to form a fairly coarse fiber used for mesh bags, for seat covers, or for general use as twine. The twisting sheet may be impregnated or coated in this operation.

Paper plates are an example of die forming as applied to paperboard. Carefully machined male and female dies are used to distort the fibrous structure of the base sheet so that a flat piece of paperboard is permanently deformed and will retain the shape of the die. Control of moisture, die temperature, pressure and "dwell" of the press are essential if clean reproduction is to be obtained by this process. The rolled edges on many paper drinking cups are formed by a progressive drawing process of the same category.

Embossing in sheet form, as seen in "lace" paper place mats and doilies is another die forming operation similar to the manufacture of paper plates. In roll form, embossing may be done with engraved steel rolls for the male die, rotating against a hard paper roll which assumes a reverse shape and becomes a female die. Variations of this process include the use of a steel backing roll to provide one-side embossing on heavy sheets. Paper napkins are perhaps the commonest example of roll embossing. The addition of an ink fountain and distribution system to an embossing roll results in a combined embossing and decorative printing operation.

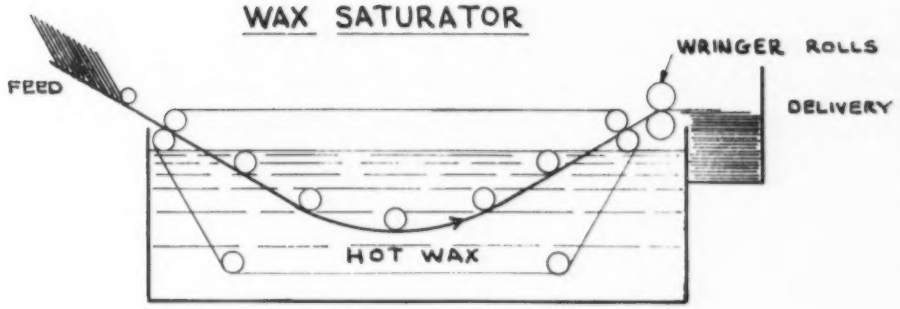
Most formed paper toys are die-cut or pressed from sheets made plastic by an excess of moisture. After forming, these objects are air dried at relatively low temperatures.

Summary

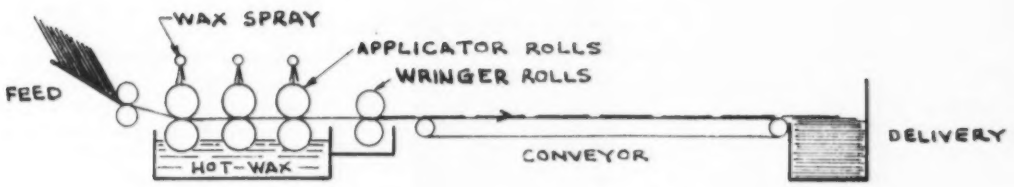
The fundamental paper converting operations which have been introduced in this discussion form the basis for the huge converting industry. Many of these operations will be discussed later in greater detail, but they have been presented here in a brief form so that when they occur in the presentation of material dealing with specific products they will be familiar. Some operations may have been ignored, and others given less space than they deserve, but I have attempted to present most of the operations which are used singly or in combination by paper converters. I have attempted to outline the steps taken in transforming blank rolls of paper into the host of useful products that are seldom out of sight or reach in our homes, our stores, our jobs, and our entire lives.

WAXING

WAX SATURATOR



HOT WAXER



COLD FINISH WAXER

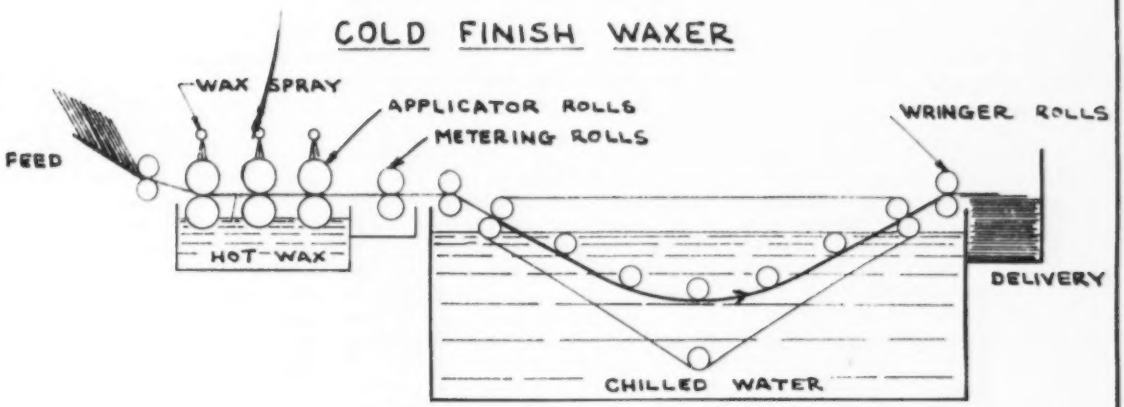


FIG. 10

Adhesives for Paper

R. T. Elias
Associate Professor
Pulp and Paper Curriculum
Western Michigan College

Paper is a thin material. We can not nail it or screw it together any more than we can a piece of cloth. It tears easily—especially along a line of perforations — so stitching fails as a method of fabricating paper. Various ingenious ideas have been used: zigzag stitching, "cushion stitching," etc., but the perforations are still there as a line of weakness, and they are often objectionable in themselves as points of leakage. Cellulose is not a thermoplastic. It does not melt and flow, so we can't weld it. Fortunately, paper can be *"stuck"* together. It can be glued, pasted, etc., and if this were not true, large sections of the paper converting industry could not exist, either because they could not make their products or because their customers could not use them.

Many paper products owe their utility to adhesives. They are rigid because of adhesives; they retain their shape or seal tightly and efficiently because of adhesives; they possess functional or decorative parts or surfaces because of adhesives; in many cases their usefulness consists of *sticking* where they are put. "Consider the postage stamp, my son. It sticks to its job till it gets there." Consider also a gummed tape, a ready-to-use wallpaper, an end-label for a loaf of bread.

Then, too, the utility of many products depends not only on the fact that they can be *made*, but upon the fact that they can be made *cheaply*, which means *fast*. Never forget the competition—and the paper converting industry *does* have competition. For example

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in every factory cafeteria there must be a price level for paper cups above which the management considers it cheaper to wash and sterilize china, glass, plastic, or metal cups. What happens to the price of paper cups if a cup machine runs faster, if the same labor and fixed charges are spread over say, twice as many cups? More people can afford to use them and throw them away.

Adhesives must hold, must hold quickly, and must be cheap per unit of converted paper product (which means, for one thing that they may not introduce any operating "bugs" that impedes production). In addition, it is also possible for an adhesive film to confer advantages over and beyond those of "stickingness." It can constitute an oil barrier or a moisture barrier or add appreciable weight or be an added structural unit as in stiffening the arch of corrugated paper. Obviously, the adhesives chemist is an important man in the converting industry.

As a matter of fact, certain adhesives used in paper mills, before the converter ever sees the paper, can be important to him. Splices must hold at fast converting speeds and under converting conditions and must not be thick, lumpy or wrinkled as they might damage converting equipment. If you'll pardon a personal example from one of my earliest papermaking problems, the trick was to splice a lightweight and fairly porous sheet so that it could be supercalendered and waxed, the splicing to be done against the rewound roll without adhesion to the layers below, the splice to be of minimum thickness and not to melt under the temperatures of converting. This might seem like a little thing, but every successful splice saved a lot of time and quite a few feet of paper.

Now, what raw materials are available to an adhesives chemist and what kinds of adhesives can he make? Before we classify them let us remark that the list is extensive and rapidly growing. In this day of "tailor-made" molecules, when we no longer have to be satisfied with Mother Nature's products and adjust our processes to fit those products, we have profited from the advances of the plastics industry, the synthetic rubber industry, the synthetic organic chemical industry in general. We have learned how to

modify the time-honored materials and to make new ones, never seen before. More and more it is the process which specifies the adhesive rather than the adhesive which dictates the process, and nowadays most any surface can be adhered. As a rule, if the right material is not immediately available, one can be made to the requirements of the specific job.

Adhesion

There is, of course, no perfect universal adhesive and there probably never will be such a one, because what sticks to a non-polar surface does not stick well to a polar surface, and vice versa. That is, there should be a chemical similarity between the adhesives and the material to be joined. Aqueous solutions do not cling to water-repellent surfaces. The adhesion of polyvinyl acetate toward cellulose can be increased by partial hydrolysis, which produces hydroxyl groups.

This brings us to a consideration of how adhesive bonds are formed. First, they can be purely mechanical. This is a simple concept. If two porous surfaces are smeared with paste and the paste enters the pores of each, perhaps actually surrounding some fibers of each, then if the surfaces are brought together and the paste is converted to a solid or at least to a high viscosity liquid, it holds in both directions like the roots of a tree, and if shrinkage occurs during the hardening, the surfaces are pulled together tightly. If the adhesive is chemically like the surfaces to be joined, then it penetrates the pores better, instead of being just mechanically forced in, and the paste holds better because the tree has more, deeper and finer roots.

A mechanical "grab" is not, however, essential to adhesion, as witness the fact that glue will hold so tightly to polished glass as to actually pull away the surface of the glass. A thin film of water between two clean microscope slides will hold them so tightly than an attempt to force the slides straight apart may result in the glass being broken. On the other hand, if the slides are slightly greasy, water will not hold them together. That is, where mechanical adhesion cannot occur because surfaces are smooth and nonporous, "wetting" is essential. There are degrees of wetting, however. Two liquids may wet the same surface yet one may show a flatter angle of contact with that surface. Where viscosities are equal, one will spread faster than the other. The complete theory is complicated, and those who are interested may turn to the article by McLarr and Hofrichter in the 1947 Technical Association Papers and to that by McLarr in the 1948 issue, but suffice it here to say that molecular attraction is essential and there must be enough mobility of the molecules of an adhesive to permit its molecules to come into close contact with the surface to be adhered, so that molecular orientation may occur and molecular forces come into play. Dry glue does not stick to glass. Molecular mobility is attained by solution and heat or, in the case of some other materials, by melting or by use of low viscosity monomers. This kind of adhesion explains how we can stick such nonporous materials as metal foils, coated cellophane, coated glassine, Saran, Pliofilm and the like.

Of course, bond strength is affected by the toughness which the adhesive itself attains when it dries or sets. Some materials become brittle. Some never do become truly solid. They become viscous liquids or plastic (as defined by Bingham) or "pseudoplastic." If they show any yield value at all it is low, and beyond that they flow like fluids. Many a person has found that you can't use pressure-sensitive tape to hang a picture. Flow is *slow* under the low stress, but it does occur just the same.

Bond strength should not be confused with "tack" or "tackiness." A tacky glue or paste is one which strings out and experts a considerable pull. It will hold surfaces together by itself while still in the wet condition. On the other hand non-tacky films must be held together until set. Once they are set, however, the bond may be very strong. Some of our strongest adhesives, including some of the modern synthetic resins, are non-tacky as applied.

Getting back to the classification of adhesives, we many divide them as "water base," "solvent or lacquer base," and "hot melts," remembering that within each class there are great chemical differences.

Gelatine Glue

Under "water base" we have first; solutions and colloidal systems such as pastes, gels and sols, both separate and in combination. The earliest of these was probably glue, known and used for over 3,000 years (1). Properly speaking, "glue" is a protein material, largely gelatine, obtained by hot water extraction from animal hides and bones and sometimes from the heads, skins and other parts of fish. Nowadays, the term "glue" has been applied to mean any adhesive, and, in fact, some actual glue has not been called by that name by its manufacturer, who preferred to call it "protein colloid."

Glue was once the only adhesive for pigment coated papers, and it was by far the best tub-sizing material. In both fields it lost much ground. In fact, in coatings relatively little is still used, but while it has been replaced in some fields it has found many new applications. In 1950 150 million lbs. of glue were used in industry, and the demand is constantly increasing.

Glue is sold on the basis of jelly strength, the force in grams needed to depress a standard plunger 4 mm. into a gel produced under certain specified conditions. Weak jelly runs about 30 grams, exceptionally strong jelly about 500. Hide glues run from low medium (about 130 jelly) to the highest testing grades. Bone glues run from low to medium, that is, to about 175 or so. Pound for pound, a medium grade glue has about the same pigment bonding strength as casein. It should be remembered that there are other properties of glue beside jelly strength, such as color, pH, ash content, etc., which affect its usefulness and price.

Glue should not be overheated. Unless it is finely pulverized, it should first be soaked in cold water and then heated, indirectly, to no more than 140° F. It is outstanding in its properties of fast-set, quickly developing holding strength, and by use of chemicals its gelling temperature may be lowered. For example, thiourea can yield glues which do not gel at ordinary temperatures. Glue is very strong, with tensile strength in the range of 10,000 lbs. per square inch. It is not precipitated by alkalies or acids, nor is it degraded rapidly by acids or alkalies within normal limits of use. Glue is soluble only in water. It resists grease, oil, alcohol and other non-aqueous chemicals. It is compatible with many other adhesive solutions and emulsions such as starches, gums, casein, latices, etc. It may be made water resistant by use of alums or formaldehyde and by dispersing oils, fats, and waxes in it. It may be plasticized by addition of molasses, invert sugar, sorbitol, glycerine and the like to form tough rubberlike materials. Printing ink rollers are usually made this way, and many people are surprised to find that these rollers have no rubber in them. Think of this as a typical example of "plasticization"—the same thing is common among plastics and synthetic resins—an added ingredient can change a hard material to one which is tough and stretchy, and further addition may leave it permanently sticky or tacky.

Glue is the most used adhesive in the manufacture of gummed tapes. It is used also in bookbinding and catalog binding, both to anchor the pages and to attach the covers. Much glue is used in the manufacture of paper boxes, both folding and set-up types, where it lends itself well to high speed opera-

tions. It is used also in the manufacture of convolutely-wound and spiral-wound containers, where in addition to its service as an adhesive, the glue film sometimes serves as an oil barrier, and much of it is used in making sandpaper.

Casein

Casein, too, is a protein and makes a strong adhesive. It is prepared by coagulation of skim milk and usually is sold as a coarse powder. It swells in water, but unlike glue, it does not dissolve unless the solution is rather strongly alkaline or acid. Upwards of 35,000,000 lbs. are used per year in the coated paper industry, dissolved in various alkalies, since the acid solutions are said to be not suitable for paper coating. According to Tappi Monograph #9, casein comprises 30 per cent of the adhesives used in all paper coating, 40 per cent of the adhesives used in conventional conversion paper coating. Casein adhesives can be rendered highly water-resistant, more resistant than glue can be. In some cases the waterproofing agent can be mixed right into the adhesive, and the water resistance develops slowly upon drying of the film. Casein is sometimes mixed with latices or with urea-formaldehyde resins, and it is often used as a stabilizer for emulsions. In general, however, casein shows poor compatibility with materials which might be tried as casein extenders, and often the blend is disappointingly weak.

Soya

The protein from soya beans is used in much the same way as casein. It is available as soya flour (which runs about 50-55 per cent protein) or as chemically isolated protein. Compared to casein, it yields lower viscosities at equal solids contents and it has greater tolerance for formaldehyde. It is more susceptible to heat than casein and should not be heated over about 130° F. As a pigment binder it is about the equal of casein, and Tappi Monograph #9 shows that in 1946 about 10 million lbs. of flour and 7,500,000 lbs. of isolated protein were used in paper coatings. In the manufacture of washable wallpapers, soya protein is used as a pigment binder and is waterproofed by a two-stage process—running the printed sheet through a bath of alum containing formaldehyde. It is said that by far the bulk of the binders used for washable wallpaper are soya proteins.

Starch

In coating paper, about twice as many pounds of starch per year are used as casein. Tappi Monograph #3 is devoted to "Starch for Paper Coating." Starch is cheap, but it takes about twice as much starch as casein to achieve equal pigment binding. Beyond the field of coating, starch, and its derivatives including dextrins, constitute one of the largest classes of aqueous adhesives. Corn starch is the one most used, but others which have been used include tapioca, potato, waxy corn, waxy sorghum, sweet potato, rice, sago, and wheat. Native starch pastes are usually too viscous, and in the case of corn they tend to retrograde or "paste back," going from fluids to gels of high yield value. Consequently, starch is usually converted or modified in some way. By oxidation or by enzyme conversion, viscosities may be decreased greatly, and by roasting in the dry state with or without acid "dextrines" are produced, which vary widely in properties and may be used in concentrations up to 50 per cent solids. High solids like these are desirable where quick setting is needed, say on high speed carton-making or filling machines.

There is a great deal of "know-how" in the preparation of starch adhesives. Too much conversion can yield brittle films. Five to twenty per cent borax will increase tackiness, but too much borax makes a paste rubbery. Alkalies may be added to increase the "bite" against rosin-sized paper. Preservers, defoamers, plasticizers, and gel inhibitors may be used. There are peculiarities specific to the origins of starches. Tapioca, for instance, has greater natural tack than corn and tends to have better flow characteristics. For some reason, wheat is preferred for dry mixes for wallpaper paste. Amioca, a "waxy maize," in some ways resembles tapioca.

A large use for starch adhesives is in making solid fiber board and in similar lamination such as pasting of Bristols and "sheet lining" (in which thin sheets such as coated paper, glassine, bond, etc., are pasted to board). The adhesives used for these purposes are not suitable, though, for another major purpose, corrugated board. They set too slowly and add too much water to the board, making it soggy. A special patented process was developed to overcome these troubles (2). Four parts uncooked corn starch are suspended in one part cooked modified starch to a total solids content about 20 per cent. The latter acts as a carrier for the former. This mixture is applied and then heated to 140°-150°F. The heating is essential. The uncooked starch gelatinizes, causing a great increase in viscosity and tack, enough to hold the board together while it is cut up at the end of the machine.

Starch products are used in making grocery and multi-wall bags. A requirement here is that the adhesive will not "string out" or "throw," which would be messy, damaging the appearance of the product. Paste for side seams must be rapid setting if bottoms are to be pasted immediately after. Bottoms, however, can be pasted with lower solids, cheaper pastes, because drying time is available. Starch pastes are also used in making paper tubes and cans and in case- and carton-sealing.

One drawback to starch has been its lack of water resistance. This has been largely overcome by the addition of 8-25 per cent urea-formaldehyde resin, based on weight of starch. As a rule the resin is added to cooked and cooled starch, though there is a process by which starch and resin are cooked together(3). An acid catalyst (alum or ammonium chloride) is required, so borated starches cannot be used, hence the paste is not as tacky as usual.

Silicate

A great competitor of starch in some fields is sodium silicate. It is used in corrugating, in the manufacture of solid fiber board and in laminating aluminum to paper. It is available in different ratios of Na_2O to silica; and cohesive strength, viscosity and setting characteristics vary with the ratio. High-silica ratios set faster and produce more elastic gels. 1:3.3 is the most common ratio for laminating use and generally comes ready for use at 39 per cent solids.

Silicate produces a strong elastic bond, which, however, can be brittle if overdried. The bond is water-resistant, but sometimes the paper sizing is destroyed in the vicinity of the bond causing the fibers to let go when wet. Sometimes the alkalinity of silicate causes staining of paper. Silicate has two big advantages in corrugating: quick set and high compression strength of the combined board due to the formation of shoulders of dry silicate between the arches and the liners.

A number of other water soluble adhesives is available. Among these are the vegetable gums, a class of colloids related to sugars. Gum Arabic, a natural exudation from trees, is an example and is used to some extent in adhesive formulations. It is used as a remoistening gum on cigarette papers. Ordinary mucilage is just a solution of Gum Arabic. Certain other gums will swell in water without actually dissolving. Among these are karaya, tragacanth, agar agar, etc. These find more application as emulsion stabilizers than as adhesives themselves. Spent sulphite liquor has been employed in adhesive formulations.

One of the strongest bond formers is polyvinyl alcohol, though it is not tacky. Polyvinyl alcohol is strictly synthetic, being made by hydrolysis of polyvinylacetate, and it is available in a wide range of molecular weights (which means a wide range of viscosities) and the degree of hydrolysis may be varied, leaving more or fewer acetate groups and thereby modifying both the adhesive power and the water sensitivity. It has a higher bonding strength for pigments than any other usual adhesive, it is easy to dissolve and needs no preservative. It has excellent color and forms very tough, flexible, oil-proof films. It can be made water-resistant, and it is compatible with other adhesives. On the other hand, borax and certain other chemicals must be avoided, and the cost of polyvinyl alcohol is relatively high. The hot-water-soluble types show fair to good resistance to cold water. It is used to build up the viscosity of certain emulsions, as for instance those of polyvinyl acetate, and it is used along with starch to make water-resistant laminating paste.

Water-soluble cellulose derivatives, carboxymethycellulose, hydroxyethylcellulose and methylcellulose show excellent adhesion to paper, and are easily handled, are colorless, odorless, nontoxic, and greaseproof. They find some specialized uses, but their cost is relatively high, and while they can be made water-resistant, this is nevertheless a problem. Methylcellulose has the peculiar property that its solutions gel when heated.

Emulsions

Also under the heading of "water base" adhesives we have emulsions, systems of globules of liquid or semisolid suspended in water as the continuous phase. These have become increasingly important in recent years and have rapidly multiplied in number. They include such products as natural and synthetic rubber latices, synthetic resin emulsions and asphalt emulsions. Advantages are, first, very high solids content, so setting rate is fast and little drying is required. Second, on a dry solids basis they are cheaper than lacquer type adhesives. Third, they can accomplish some things which other adhesives cannot do. For example, suppose we wish to cement together two porous surfaces but we want the glue line to be a flexible water-proof continuous film. A lacquer adhesive thin enough to spread easily would soak in, leaving the glue line thirsty. If, however, we were to emulsify a heavy bodied lacquer, we would enjoy the easy spreading qualities of the emulsion and the filming properties of the lacquer. You see, the viscosity of the emulsion does not reflect the viscosity of the disperse phase; it depends only upon the number and sizes of the globules. Another example: (4) acetate sheeting can be laminated to chipboard with a resin-emulsion because the water in the emulsion wets the board, and the organic solvent in the emulsion wets the acetate. In contrast, a lacquer would adhere well only to the acetate whereas an aqueous-solvent glue would adhere only to the paper and not to the acetate.

Natural rubber and synthetic rubber latices are widely used, often for laminating metal foils to paper. They are characterized by strong adhesion and high flexibility. They can be formulated with curing or vulcanizing agents present to produce highly water-resistant films, and they can be mixed with starch, at the expense, however, of water-resistance.

Bituminous emulsions are sometimes used for laminating. They are like the usual asphalt emulsions but contain plasticizers to confer tackiness. They are often mixed with starch or other adhesives. In some cases they add little or no water-resistance to starch, but some newer asphalt emulsions are claimed to confer water-resistance.

Resin emulsion adhesives can be made in two ways: by emulsifying the monomer and reacting it in the emulsified condition or by softening the resin or dissolving it in an organic solvent and emulsifying the product in water. The large number of resinous materials which are available makes it possible to produce resin emulsion glues having widely different properties, i.e., emulsions can be selected for particular properties such as water resistance, grease resistance and solids content. Plasticizers can be added to control hardness and flexibility. Special solvents can be added to aid in penetration of lacquer coatings, cellophane, acetate and the like.

Polyvinyl acetate emulsion is widely used in making very fast setting adhesives often in combination with starch. If no solvent phase is present, heat from 100-125°C. is needed to bond the resin. Acrylic acid esters are often used in emulsion form. They age better than natural rubber latices and are compatible with other synthetic resins and with synthetic rubber latices.

A typical application for emulsion adhesives is found in paper milk containers. The bond must be made rapidly, on high speed production machines. It must be water resistant and odorless, and it must not dissolve in hot wax or come apart at the temperature of hot wax. With all this, it must be as cheap as possible.

Non-Aqueous Solutions

In contrast with water-base adhesives, there are the "lacquer-type" adhesives, used where water is impractical or objectionable. They are solutions, in volatile organic solvents, of natural and synthetic resins and elastomers, with and without plasticizers. In general their cost is higher, which limits their use to specialty applications, but for certain purposes they are essential or preferable. Some materials are impervious to water and cannot be laminated with aqueous or emulsion-type adhesives. For example, moisture-proof cellophane and varnished or lacquered papers are not readily wettable by water, and besides they prevent water vapor from escaping, thus preventing the glue-line from drying—as, for instance, in adhering labels to glass or metal.

Lacquer-base adhesives have the important advantage of minimizing the distortion or curling or swelling, warping or wrinkling which often occur when paper is exposed to moisture. One disadvantage is that sometimes they will cause ink to bleed.

Formulation of these adhesives is simpler than the formulation of lacquers for surface coating. The delicate solvent balance required to prevent "bloom" and to obtain gloss is not required. High drying rate is the primary consideration. Neither is the choice of resins and plasticizers as demanding as for surface work. In many cases the adhesive need not harden completely; in fact, it frequently is better if it doesn't. After all, a glue film is in a protected position.

Shellac dissolved in alcohol, rosin dissolved in turpentine have been used as adhesives. Hercolyn resins (hydrogenated methyl esters of rosin) have been used together with film-formers and resins of other types to obtain the whole range from non-tacky to pressure-sensitive mixtures. Staybelite resins (glycol esters of hydrogenated rosin) have been dissolved to yield very tacky adhesives, which can include also ethyl cellulose, rubber, chlorinated rubber, polybutene and nitrocellulose. Synthetic polymers can be used. For example, polyvinyl chloride acetate in methyl ethyl ketone, cyclohexanone and propylene oxide has been used in hot drink cups.

Nitrocellulose lacquer, containing a plasticizer and either natural or synthetic resins, in a mixture of 60 per cent inert solvent, 40 per cent active solvent, has been used for moisture-proof cellophane. Rubber cements belong in this general class—natural and synthetic rubbers dissolved in gasoline, naphtha, benzene, carbon tetrachloride, trichloromethylene, and the like. Dammar and manila resins, ester gum, and

coumarone-indene resins are often added.

Hot-Melts

The next logical step, having progressed from water to more volatile solvents, is to eliminate the solvent entirely. This brings us to the "hot melts," materials which melt or thin out when heated and set or thicken when cooled. They are usually waxes or wax-like solids plus a synthetic resin and a plasticizer. They are naturally very fast setting and have found use on glassine, chipboard, cellophane, metallic foils, acetate, etc. Cost and hazards of solvents are eliminated, and surfaces may be adhered which are impervious to water and organic solvents. Their most important use is probably in the manufacture of water-vaporproof laminates, in which they function not only as adhesives but also as continuous moisture-resistant barriers.

For this latter application, microcrystalline waxes are favored. Their advantages over paraffin for this purpose are said to be: greater tackiness, greater flexibility, more resistance to water, grease and water-vapor, better adhesive properties. Asphalt is often used similarly and may be blended with petroleum waxes, resin esters, coumarone-indene resins.

As with lacquer-type adhesives hot-melt "glue" formulations are less critical than hot-melt surface coatings. Blocking is no problem, and on the other hand, a certain amount of brittleness can sometimes be tolerated. This is equivalent to saying that lower molecular weight polymers may be used, or larger proportions of the simpler compounds, and hence the mixtures may be of lower viscosities at application temperature than is permissible for coating.

Ethyl cellulose finds wide application in hot-melts, due partly to its broad compatibilities, especially with many waxes. Low viscosity polyvinyl acetate is also frequently used. Its softness, which is objectionable for surface coating and which makes the acetate-chloride copolymer preferable for coating, is of no disadvantage here and, in fact, of some advantage. Rosin and certain rosin derivatives are often used in hot melts, and cyclized rubber, chlorinated rubber and some synthetic rubbers are also used.

It is hoped that this brief glimpse at the field of paper adhesives will serve to emphasize the wide variety of materials available for the purpose and the almost limitless range of properties obtainable through various combinations of materials and various ways of applying them. The study of adhesives justifies full-time specialists. The adhesives chemist sometimes uses materials known through the ages and, if your process requires, he can use the newest product from the polymer laboratories. If you are in the paper converting business, he's a good man to have on your side.

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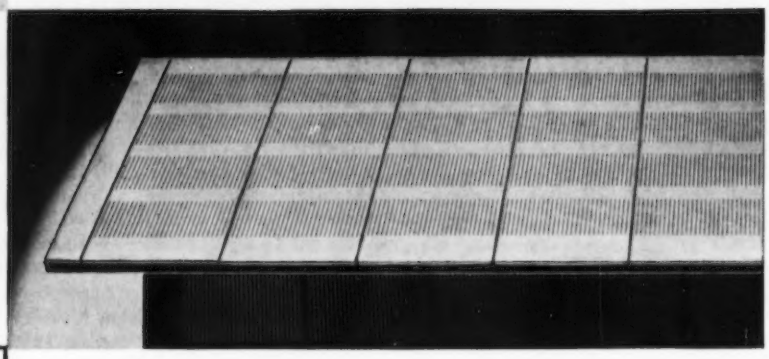

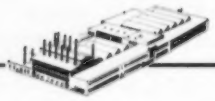

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Color and Color Control in Converting

F. L. Wurzburg, Jr.
Interchemical Corp.,
Printing Ink Division

Introduction

In approaching the subject of color and color control, particularly as it relates to the converting industry, it is logical to start by posing two questions:

1—Is the control of color necessary?
2—How closely must colors be controlled to satisfy this need?

In attempting to find answers to these questions it is important to realize the revolution that has taken place in the past two decades both in the amount of color used and in the manner in which color is judged by the consumer. In the last fifteen years, for example, the ratio of color pages to black and white pages in national publications has increased from 300 to 500 per cent, while in the packaging field the increase has been even more spectacular. Futhermore, during this same period we have seen the rise of the supermarket and the chain store where packages are displayed in close proximity to one another under almost ideal conditions for visual comparison by the consumer instead of being stored under the counter to be produced on demand.

The mass production techniques that have been so thoroughly developed in this country have conditioned the public to accept interchangeability of parts as commonplace and to consider non-uniformity or non-interchangeability as evidence of inferior quality. This conditioning of the consumer causes him, or perhaps more often her, to judge the quality of the contents of a package by its appearance. If the packages for a given product do not appear uniform, doubt is raised in the mind of the buyer concerning uniformity of the product itself. Another aspect of the appearance of the package to which customers are sensitive is the impression it may leave of its freshness or lack of it. This is of course particularly true of food packages or those of other goods which may deteriorate with age. With this type of product the housewife will almost invariably select the fresher-looking of two packages even though the variation in appearance may have nothing whatsoever to do with its age. All these factors indicate that the answer to the first of the two questions posed above it "Yes."

Francis Lewis Wurzburg, Jr., of Interchemical Corp., Printing Ink Division, has been associated with color, and particularly its use in the graphic arts industries, since his graduation from Yale University in 1932.

After a few months with the Hilton-Davis Co., Cincinnati, he joined IPI early in 1933 as a chemist, and began work in 1937 as a physicist on an electro-mechanical color-correction device to reduce the hand correction necessary on process printing plates. This work was interrupted by World War II, when Mr. Wurzburg served in the Aerial Photographic Laboratory of the Army Air Corps at Wright Field, but was resumed in 1945 when he was appointed Manager of Interchemical's Precision Color Laboratory.

Since the fall of 1950 he has been active in developing color control and standardization procedures for IPI and its customers. A number of Mr. Wurzburg's inventions in connection with color reproduction have been patented.

The answer to the second of these two questions is considerably more elusive and it is in general impossible to give a wholly satisfactory answer. It certainly is true that the modern methods of display cited above, where packages of the same product are closely juxtaposed on the shelves under almost ideal conditions of illumination and viewing, have made the consumer conscious of smaller differences of color than he ever was before. However, a great deal more work must be done to determine just what differences can be tolerated before producing a detrimental consumer reaction.

Factors in Package Design

Now that a need for color control has been established, let us review briefly the history of a package from its inception in the mind of the artist to its final commercial production. In general, of course, the design of the package originates with the purchaser of the printing, either in his own advertising department or in that of an advertising agency. Often mistakes made at this initial stage can cause a great deal of trouble later in the production of the package. In the first instance, the artist often employs materials which are very different in characteristics from those which must eventually be printed on the package. Furthermore, too frequently he is apt to be unaware of the limitations placed upon the pigments which the ink manufacturer can employ. These limitations arise from a variety of factors, such as cost and the end-use requirements which the package must meet.

For example, the pigment known as ultramarine blue is not affected by alkali and is therefore suitable for a package containing an alkaline product such as soap. It is however destroyed readily by acids and could therefore not be used for a package containing a product acidic in character. Again, the shade of blue generally used for process work can be realized with several different pigments. The cheapest of these, however, is extremely fugitive to light and could not be used where any appreciable light fastness is a requirement. Where extreme permanence is desired the most expensive pigment of this shade must be em-

ployed. Hence economic and end-use factors must be properly balanced if the greatest efficiency is to be derived.

Comparisons similar to those made in the paragraphs above can, of course, be made for other colors and for other end-use requirements, but these few will at least serve to illustrate the nature of the restrictions imposed upon the ink manufacturer by end-use requirements in general. If these requirements are taken into account at the initial design stage of the package, a great deal of future trouble and expense in production can often be avoided.

There is one other factor which can help a great deal in facilitating control in production if it is taken into account at the design stage. For reasons which will be discussed later, it is generally much simpler to maintain uniformity of color on the press with an opaque rather than a transparent color. Therefore it is desirable whenever possible to employ colors which can be formulated with opaque pigments.

Preparation for Production

Once the design has crystallized and been approved by the purchaser, the printer or converter will decide on the type of equipment, rotation of colors, etc. which he will use in the production of the package. His next step will be to call in his ink supplier and request him to quote on inks which will match those in the approved design and which will be suitable for his printing conditions. It is, of course, very important that the ink supplier be furnished full information concerning the end-use requirements as mentioned above, together with any special tests which the customer demands that the package must pass. The ink manufacturer will then match the color or colors of the design by blending pigments of the proper color and other characteristics and will submit proofs for approval.

It would be desirable at this point to be able to have a perfectly clear "yardstick" with which the acceptability or unacceptability of these matches could be measured. This is, however, very seldom the case for a number of reasons. In the first place the surface finish characteristics of the ink as printed on the board will generally vary to a greater or lesser extent from the surface characteristics which the artist has achieved with the coloring and other materials at his disposal. Changes in surface characteristics, such as gloss, greatly affect the appearance of colors and it is sometimes very difficult to arrive at an agreement as to what constitutes a reasonable match when these characteristics vary to a marked extent.

Fig. 1

One of the reasons for this is that different methods of illuminating and viewing colored surfaces will affect differently colors with different finishes. An extreme example of this will perhaps serve to illustrate the point. *Figure 1* has been prepared by printing a dull or matte finish ink and then overprinting one-half of it with a clear, transparent varnish. This varnish, being to all intents and purposes colorless, has not affected the color of the ink at all in the physical sense. However, under most conditions of illumination and viewing which would be employed in practice the two halves of *Figure 1* would not be considered a very close match. The mis-match will be most apparent if it is viewed perpendicularly when illuminated from an angle of approximately 45° by a single source of light, as indicated diagramatically in *Figure 2*. Other methods of viewing and illuminating can make the match appear better, and in fact a perfect, or near perfect, match will be achieved if the figure is held horizontally while the observer is standing in a wide open area with no reflecting surfaces around him with the illumination coming from a completely and uniformily overcast sky.

The difficulty described in the last paragraph, together with certain other differences between original copy and

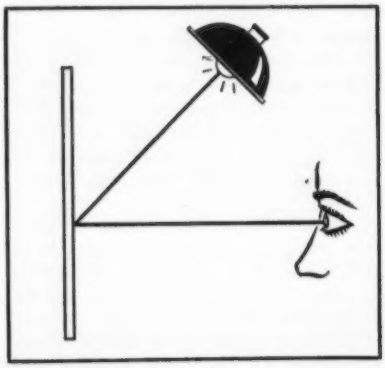


Fig. 2

practical matches made with printing ink, make it difficult to find the clear "yardstick" mentioned previously at the present state of our knowledge. It is usually necessary for the parties concerned to arrive at a mutually acceptable interpretation by taking into account the practical factors involved.

When agreement has been reached, the converter will then order from the ink manufacturer a quantity of ink sufficient for the production order. What steps does the ink manufacturer now take to insure that the production batches of ink will be identical with the small sample which he prepared for approval? In the first place of course, he will mix the ingredients for the production batch from exactly the same ingredients and in exactly the same proportions as were used for the approved match. After the ink has been mixed and ground, he will then compare this production batch against a retained sample of the original match by placing the two wet samples on a piece of paper and "drawing them down" with an ink knife. This "draw-down" provides two juxtaposed ink films of identical thickness admirably suited to the visual detection of small color differences. A similar comparison is usually made of the same inks reduced, or "bleached," with many times their weight of white ink in order to detect small differences in tinting strength.

In the case of the draw-down and bleach the comparisons between the production batch and the retained sample are made visually, and if any visual discrepancies are evidenced, the production batch will be altered to eliminate them. In a draw-down or bleach the comparison between the two colors is made in such a manner as to take full advantage of the sensitivity of the eye to small color differences. This method of comparison is in fact so sensitive that only the most elaborate and expensive instruments can distinguish differences that cannot be seen with the eye under these conditions. It would, of course, be desirable if, at this point, instrumental methods were available with which to judge whether these production batches were within appropriate tolerances from the original match. Work has been done and continues to be done toward this end, but at the present time the eye still remains the most satisfactory method.

Production

Now that the ink manufacturer has supplied the converter with production quantities of the inks for the package, the next and final step is the control of the color during the production run. In the past some of the largest variations

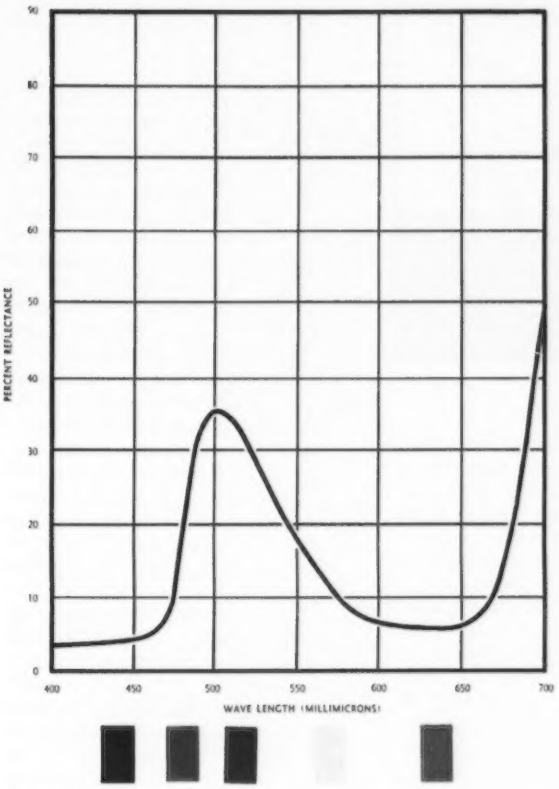


Fig. 3

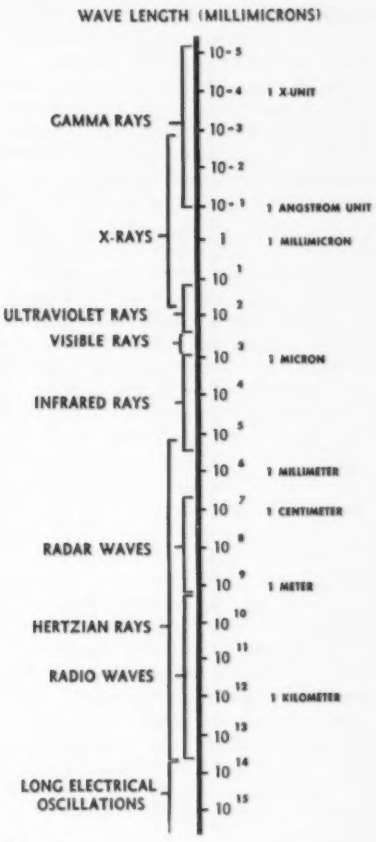


Fig. 4

in color have occurred at this step. The color of a printed job can vary markedly with the thickness of the ink film deposited on the board. This variation is greater the more transparent the ink, but it can never be eliminated entirely since complete opacity cannot be achieved with coloring materials in the extremely thin layers produced by printing.

Fortunately there are relatively inexpensive and convenient instruments, based upon optical and photo-electric principles, which can aid materially in controlling this sort of variation if intelligently used. These instruments fall into the category known as densitometers and perhaps the two which have found greatest application in the printing industry to date are the Densichron and Photovolt. The principles upon which these instruments operate to control film thickness will be described later when we take up the descriptions of instruments in general.

Standardization

Let us continue with the history of the package by considering the problems raised in maintaining the colors of the package constant over a protracted period of time. Suppose that after six months or a year or more have elapsed, the converter receives a reorder for the same package. What have been the methods employed in the past in attempting to insure that the new lot of packages does not vary significantly from the original one? The ink manufacturer of course has retained wet a sample of the ink furnished for the previous run. Is there any assurance that this sample has not changed in some respect since it was originally prepared? Unfortunately in general there is no such assurance since, even though it has not been exposed to the fading effects of light, chemical reactions between various componets of the mixture may have occurred. The customer, the converter, and the ink manufacturer will probably have retained O.K.'d samples of the production run. Can we rely on these? Here again the answer is that in general we cannot, since these retained proofs have had varying amounts of exposure to light, handling, and possibly fumes of different sorts, any or all of which may have changed the colors to some degree. The ink manufacturer could conceivably duplicate the formulation of the previous ink by mixing the same components as used previously in the same proportions. Would this be a reliable method of insuring that no changes were occurring? Even if the raw materials which the ink maker received from his

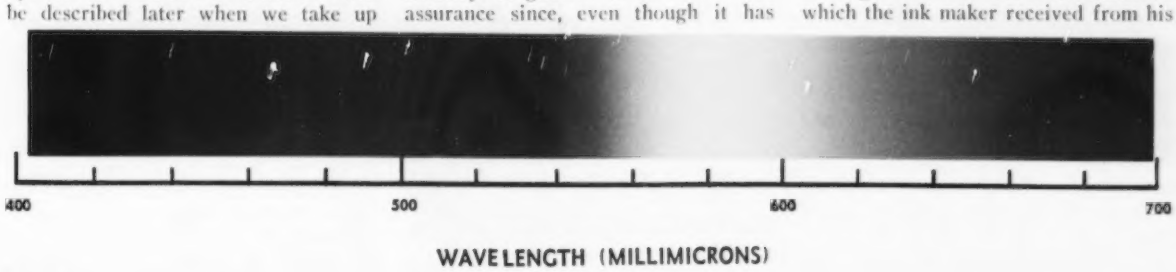


Fig. 5

supplier had not changed in any respect since the original ink had been prepared it would still be necessary to print the inks on the identical board under the identical conditions and with the identical film thickness as previously. It is almost impossible to be sufficiently certain of any one of these factors to be confident that the new package will be a duplicate of the original one. Of course since this new package will not usually be compared directly with the original one it might be argued that a slight change would not be serious, and this is indeed true in many cases. However, over a period of time these changes can add up in such a way that eventually the package may bear little resemblance to the original one and may lose its sales appeal. This gradual change or "drift" over a period of time has been a source of trouble in the past. It would obviously be desirable to be able to make a permanent physical record of the colors in the originally approved package in order to be able at some future date to determine if changes had occurred and to rectify them. There are now available instruments called spectrophotometers with which such a permanent record can be obtained. This record is in the form of a curve on a graph such as the one shown in *Figure 3*. The significance of this type of record will be discussed in a later section.

Specification of Color

It has been implied several times in what has gone before that the perception of color in the mind of an observer is a rather complex thing and that it is influenced by factors other that the mere pigmentation of the ink or other coloring material. Before describing some of the instruments mentioned in the preceding sections it is advisable to consider in some detail just how it is that color is preceived.

Light Sources

To begin with, it is obvious that without any source of light there can be no perception of color. This may seem to be a very obvious and unnecessary statement. However, the source of light is all too frequently disregarded and people tend to think of the perceived color of an object as an intrinsic property of the object without considering the quality of the light by which it is illuminated. The obvious place to start then is considering color is with light sources. These can be classified into two broad categories: natural and artificial. Among natural sources we have direct sunlight, north skylight on a clear day, and overcast skylight, the first two usually termed average daylight.

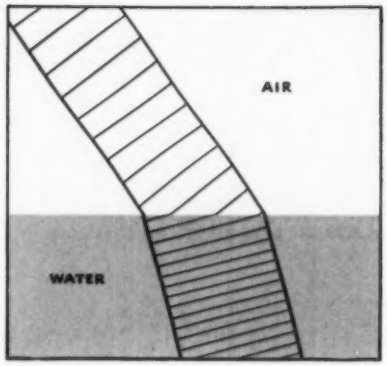


Fig. 6

Among artificial sources the more common are incandescent tungsten, and fluorescent lamps. Aside from the obvious fact that one source looks bluer or yellower than another, is there some way that the properties of these light sources can be specified?

Light consists of electromagnetic radiations, the visible spectrum comprising only a very small portion of the entire electromagnetic spectrum. Electromagnetic radiations are identical in all respects except their wavelengths, and these range from the very long waves of radio broadcasting down to the very short ones of x-rays and the still shorter ones emitted by radioactive materials. The chart of *Figure 4* shows the entire electromagnetic spectrum and the position of the visible spectrum within it.

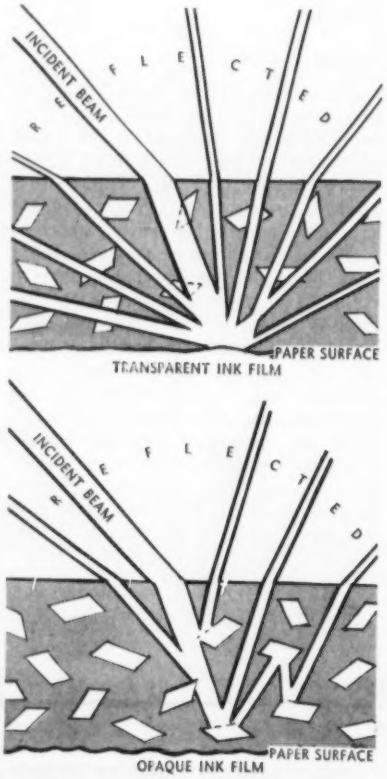


Fig. 7

The fundamental unit of length in physics is the meter—one meter equals 39.37 inches—but the wavelengths of visible light are so short that the unit most generally employed for measurements in the visible region is the millimicron (abbreviated mμ). A millimicron is a thousandth of a micron, the micron being in turn a millionth of a meter. As shown in *Figure 5* the wavelengths of the visible spectrum extend from about 400 mμ to 700 mμ.

Although light waves, in common with all other electromagnetic waves, travel with the same velocity in a vacuum, they are slowed up to a greater or lesser extent by transparent materials such as glass, water, etc. This property of transparent materials gives rise to the familiar "bending" or refraction of light rays when passing at an angle from air, for example, into water or glass. The reason for this can readily be seen from *Figure 6* which shows schematically the successive positions of the wave front of a light beam when passing from air into water. If the light ray is imagined to be a column of soldiers marching from a dry field into soft sand, the effect is readily visualized.

The ratio of the velocity of light in a vacuum to its velocity in a given transparent material is termed the refractive index of the material. The higher the refractive index of the material, therefore, the more lightwaves are slowed down by it and therefore the more "bending power" the material possesses. Futhermore, whenever a light beam crosses a boundary between two materials having different refractive indices, a fraction of the beam is reflected at this boundary and never enters the second material. The amount reflected depends on the difference between the refractive indices of the materials and on the angle with which the ray crosses the boundary. The greater the difference between the indices and the sharper or more acute the angle between the ray and the boundary, the greater the percentage of the incident light beam which is reflected and the less that which penetrates the second material. However, when a light beam passes from one material into another having the same refractive index, no bending and no reflection occurs at the surface.

We are now in a position to understand the difference between transparent and opaque coloring materials. If an ink or paint film is formulated with a pigment which has the same refractive index as that of the varnish or vehicle in which it is dispersed, the light will pass through it unde-

viated to the surface on which it is coated. If, however, the pigment has a different refractive index from that of the vehicle, a portion of the incident beam will be reflected at each pigment vehicle interface and if the film is thick enough none of the light will reach the support. This is indicated schematically in *Figure 7.*

It was mentioned earlier that electromagnetic radiations of all wavelengths travel at the same velocity in a vacuum. In transparent materials, however, the velocity of these waves depends to some extent upon the wavelength, the shorter wavelengths being slowed down more than the longer ones. This means of course that the refractive index of a material is higher for the shorter wavelengths than for the longer ones and therefore the shorter wavelengths are bent more than the longer ones when passing from a low index material to one of higher index. It is this property of electromagnetic waves which allows us to separate or "disperse" light from any source into its component wavelengths. For this purpose the most commonly used device is the prism and if light from any common source such as the sun, the sky, or a tungsten lamp is caused to pass through a prism, the emerging light will be separated into its component wavelengths, forming the familiar spectrum as shown in *Figure 8.* Although the spectrums obtained in this manner from each of these common sources will appear to be very similar, close inspection will show that the relative intensities of the different wavelengths will vary for each of them. For example, the spectrum from the north skylight will show relatively more intensity at the blue end of the spectrum and less at the red compared with that from the sun, whereas the spectrum of the light from a tungsten lamp will show relatively more intensity at the red end of the spectrum. The relative intensities at each wavelength can be measured with suitably calibrated measuring devices and can be expressed in terms of the amount of energy emitted at each wavelength by the source in question. If the energy at each wavelength emitted by a given source is plotted on a piece of graph paper, curves will be obtained similar to those shown in *Figure 9,* and these curves (known as spectroradiometric curves) now constitute complete physical specifications of the energy compositions of the sources. We have now answered the question posed in the first paragraph of this section.

Colored Materials

It should be obvious from this discussion of light sources that the com-

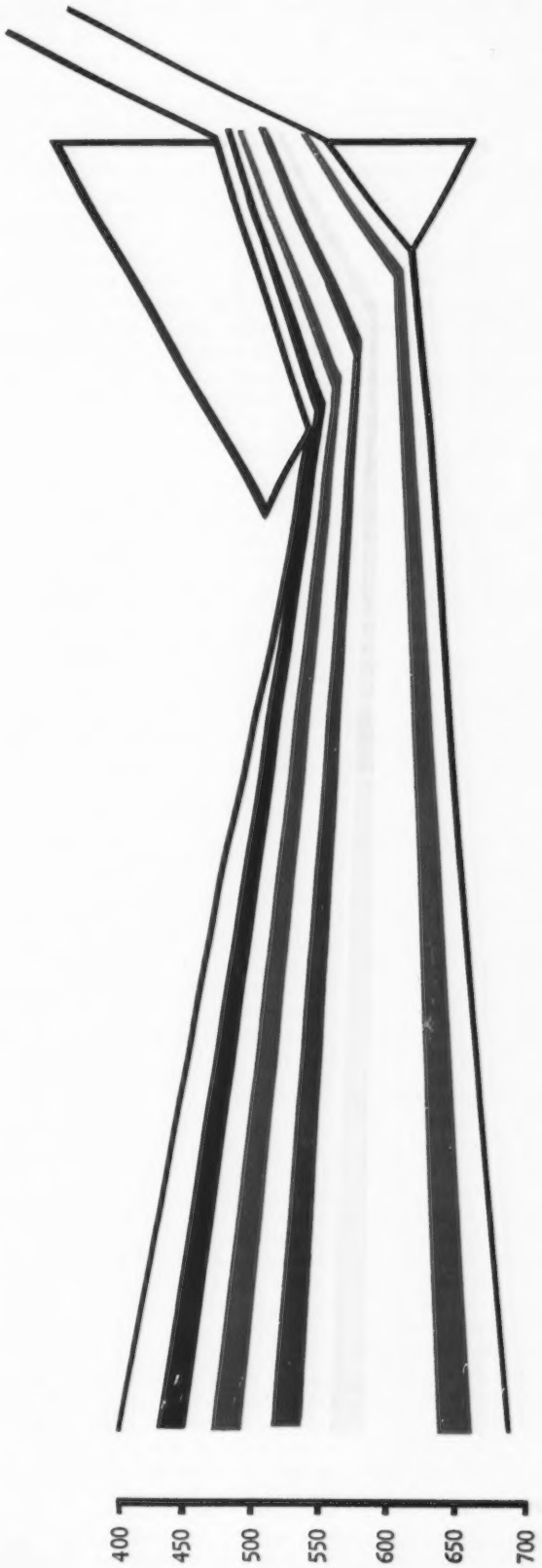


Fig. 8

position of the light energy which reaches the eye from any colored material will be profoundly affected by the quality of the light source used to illuminate the material, and of course almost everyone is aware of this who has ever purchased a fabric or other colored material under tungsten illumination and subsequently been surprised as its appearance in daylight. However, it is possible to specify the physical reflecting or transmitting properties of a material independently of the source under which it will be viewed. This is accomplished by illuminating the sample material with one narrow band of wavelengths at a time and measuring the percentage of this incident radiation which is reflected back (or transmitted in the case of a transparent material). If these measurements are made for all wavelengths in the visible spectrum and plotted on a piece of graph paper, a curve such as that shown previously in *Figure 3* will result. This is the curve of the green formed by the overprinting of a typical process yellow by a process blue ink. The fact that it is a green can readily be surmised from the curve of *Figure 3* since the color in question reflects the green wavelengths to a greater extent than those in the remainder of the spectrum. The General Electric recording spectrophotometer automatically makes these measurements and draws the curve of a material in a few minutes. This curve is known as a spectrophotometric curve and provides a complete physical specification of the reflecting or transmitting properties of the material.

It should be emphasized that this curve does not by itself tell us the spectral composition of the light reaching the eye from this material when viewed under any of the normally employed light sources discussed above. It does, however, constitute a permanent physical record of the material and it should be evident that any two materials which have identical spectrophotometric curves will match under all conditions of illumination. Spectrophotometry is the basic tool by which permanent standards can be set up and maintained but, although great strides have been made in the techniques for spectrophotometry, spectrophotometers are still relatively costly and complex and are not always adaptable to the control of day-to-day production. In the converting field their utility at the present is primarily restricted to setting up and checking working standards.

Colorimetry

It has been emphasized above that spectrophotometry does not give directly complete information concerning the appearance of a color. In order to specify this latter characteristic two additional factors must be taken into account: (1) the properties of the light source, and (2) the properties of the human eye. The physical specification of light sources has already been discussed and curves showing the spectral composition of the light energy reaching the eye from a chosen light source and colored material can readily be obtained by multiplying together wavelength by wavelength the energy values from the spectroradiometric curve of the light source and the reflectance values from the spectrophotometric curve of the colored material. *Figure 10* shows the result obtained by this procedure for the colored material of *Figure 3* and the daylight source shown in *Figure 9*.

Taking into account the chromatic properties of the human eye is a somewhat more elusive proposition. It has been recognized for many years that color perception is essentially three dimensional. Many experiments have shown that the normal human eye behaves as though it contained three independent sets of nerves, each set being sensitive to a relatively broad region of the visible spectrum. Although no experiments have proven conclusively the existence of these sets of nerves, carefully controlled experiments based on color mixture data have made it possible to determine their effective spectral sensitivity. The curves in *Figure 11* show these sensitivities for the normal human eye as adopted by the International Commission on Illumination in 1931. It can easily be imagined that, if two colored materials when viewed under a given illuminant stimulated each of these three sets of nerves to the same degree, the two materials would appear identical, and this is indeed the case. In order to determine the extent to which each of these sets of nerves would be stimulated by the light source and colored material shown in *Figure 10*, it is only necessary to multiply the curve shown in that figure by each of the sensitivity curves shown in *Figure 11* in turn. The area under each of the resulting three curves represents the degree to which the corresponding set of nerves is stimulated.

Methods have been devised for making these computations from spectrophotometric curves and data from standard sources of illumination with a reasonable degree of rapidity, but it is still laborious and time-consuming method of arriving at the desired information. More recently, elaborate and costly computing devices known as automatic tristimulus integrators, which can be attached directly to the spectrophotometer, have become available and yield the desired results as soon as the spectrophotometric curve itself has been drawn. The three figures obtained by the above-mentioned procedure are called tristimulus values and are usually adjusted in such a way that a pure white material would yield values of 100 for each of the three functions. In the system adopted by the International Commission on Illumination (known as the C.I.E. System, from the initials of the French name of that organization) the red tristimulus value is termed the X value, the green the Y value, and the blue the Z value. These values for the material and illuminant shown in *Figure 10* are X = 8.5, Y = 16.6, and Z = 10.4.

It should be emphasized again here that the tristimulus values apply to the total radiation which reaches the observer's eye and therefore include the spectral distribution of the illuminant as well as the spectral reflectance characteristics of the material. Changing the illuminant will, in general, therefore, change the tristimulus values. It is now pertinent to ask whether it is possible to have coloring materials with different spectrophotometric curves which have identical tristimulus values for a given illuminant. This is indeed possible and means that colors can be found which, although different physically, will appear to match under a specified illuminant. In general such materials will have different tristimulus values, and therefore no longer match, if the illumination is altered. Such materials are termed metameric matches and are more common than might be supposed. For example, it is a fairly common experience in color matching to arrive at a pigment mixture which matches a sample of unknown composition under some condition of illumination, and then to find a greater or lesser degree of mismatch under a different illuminant. Only mixtures which have identical spectrophotometric curves will match under all conditions of illumination and this is one of the reasons why a spectrophotometric curve is, generally speaking, a more satisfactory basic reference standard.

In practice, metameric matches cannot, however, be entirely avoided. For example, slight changes in the color of the stock or in the end-use requirements of the printed material may require changes in pigmentation of the ink or other coloring material which will result in changes in the spectrophotometric curve. It would often be valuable to know whether these changes have altered the appearance of the color significantly for a standard condition of illumination and it is necessary to compare the tristimulus values to obtain this information.

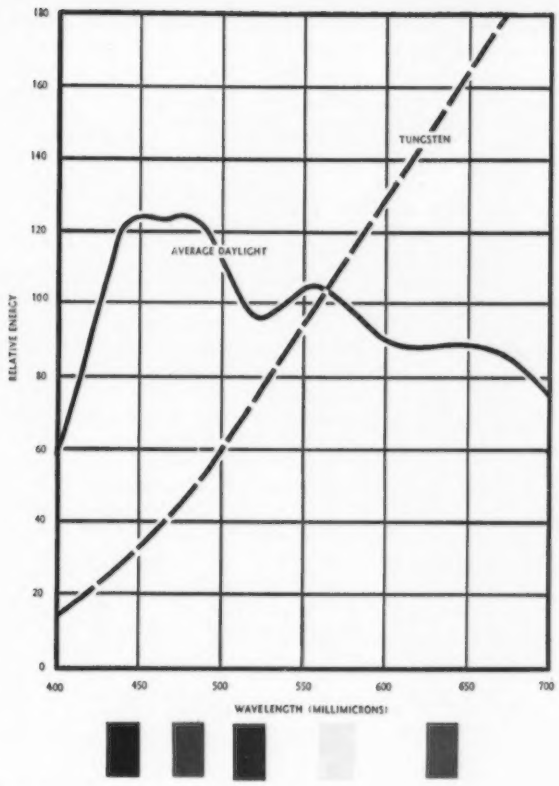


Fig. 9

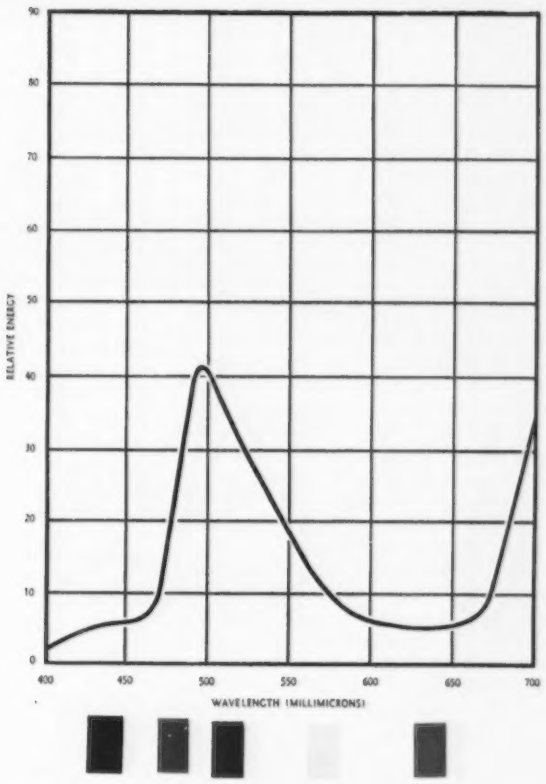


Fig. 10

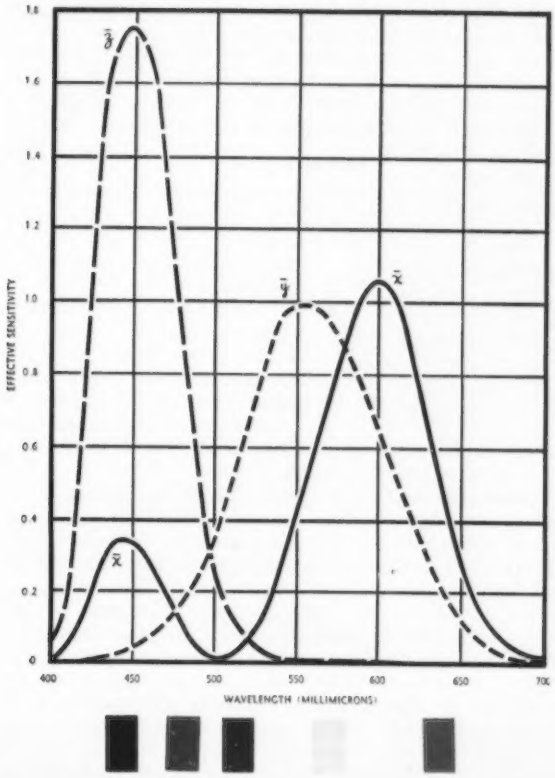


Fig. 11

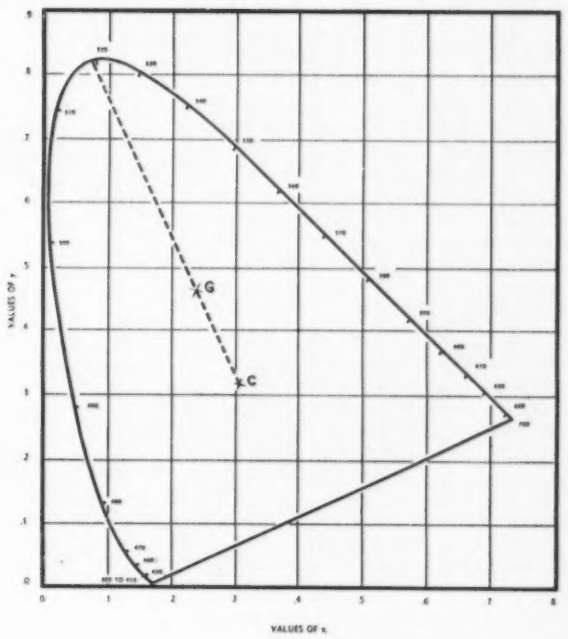


Fig. 12

Colorimeters

As indicated above, the computation of tristimulus values from spectrophotometric data is a tedious process at best and it is natural to wondor whether it might not be possible to arrive at them more directly. Much work has been done on this problem and various instruments, known as tristimulus colorimeters or, more simply, colorimeters, have been developed. These instruments attempt, through the use of color filters and photoelectric cells to simulate the spectral responses of the three sets of nerves occurring in the normal human eye. The responses of these photocell-filter combinations to a colored stimulus, therefore, yield tristimulus values directly. Although great strides have been made in the development of instruments of this type, their application to control problems in the converting field is still quite limited. This is primarily due to the difficulty in matching the spectral distribution functions for the normal human eye sufficiently precisely with photocell and filter combinations and keeping them stable over periods of time. In addition, the eye itself is an extremely sensitive mechanism for the discrimination of small color differences and to date most instruments cannot compete with it in this regard, particularly if the colors to be compared are in any appreciable degree metameric. Since it is precisely where metameric conditions obtain that tristimulus values are most useful, the reasons for the limited applicability of colorimeters can be appreciated. However, it certainly appears probable that the time will come when most of the present limitations of existing colorimeters will have been overcome and that there will then be available at reasonable cost instruments which will enable tristimulus values to be determined conveniently, quickly, and accurately.

It is not easy to visualize a color, or the difference between two colors, from their tristimulus values as such. If, however, two new quantities, x and y, are defined such that $x = X/(X + Y + Z)$ and $y = Y/(X + Y + Z)$ they may be plotted on a diagram like that shown in *Figure 12*. This is called a color mixture diagram and has several useful properties. The curved boundary of the figure is the so-called spectrum locus. That is, it is the line along which plot all of the purest possible colors consisting of radiations of single wavelengths only. The straight line joining the ends of the curved boundary is the locus of mixtures of the shortest wavelength blue spectrum color and the longest wavelength red spectrum color. These, of course, are blue-reds or purples which do not occur in the spectrum itself. All naturally occurring colors must fall within this closed figure. The point near the center of the diagram marked C shows where average daylight plots on this map, and the point labeled G where the color shown in *Figure 3* plots when illuminated by average daylight. The dashed line drawn from the point marked C through that Marked G intercepts the curved boundary at the wavelength 519.5 and this wavelength is called the dominant wavelength of the color. Dominant wavelength is analogous to the concept of hue, the properties of the diagram being such that a perfect visual match for the color G would be obtained by mixing single wavelength radiation of wavelength 519.5 and light having the characteristics of Illuminant C in the proper proportions. All colors along the dotted line, therefore, would have the same dominant wavelength and would differ only in the amount of dilution by the illuminant. The ratio of the distance CG to the distance from C to the spectrum locus is called the purity of the color G and is a measure of its saturation or "chroma." Expressed in percentages, pure spectral radiation would be of 100 per cent purity whereas the point representing the illuminant would be of 0 per cent purity. Dominant wavelength and purity together with brightness (the Y tristimulus value in the CIE system) allow of a somewhat more meaningful interpretation of a color or of the difference between two colors, than is afforded by either spectrophotometric curves or tristimulus values. For example, two colors with different Y values which plot at the same point on the mixture diagram appear to differ only in brightness. Similarly, two colors with the same Y value plotting along the same line from the point representing the illuminant differ only in purity. Colors of different hues or dominant wavelengths will lie on different lines from the illuminant. The dominant wavelength, brightness, and purity of the green represented by the curve in *Figure 3* and the point G in *Figure 14* are 519.5, 16.6, and 29.5 respectively.

Densitometry

In the section on colorimeters it was pointed out that it is very difficult to obtain from photocell and filter combinations data which correspond precisely to the spectral distribution functions of the normal human eye. However, relatively simple photoelectric devices are on the market which will readily detect the differences in reflectance caused by variations in the thickness of a printed ink film. If these instruments, known as densitometers, are properly calibrated to the light and dark limits of a particular job they can successfully be employed to control film thickness variations on a press so long as the ink and stock remain unchanged. One of their big advantages is that in the process of calibration the difference in instrumental reading between a wet film and a dry film can be taken into account thus overcoming the troublesome problem of "dry-back."

Color Order Systems

Those readers familiar with the various color order systems such as the Munsell System and the Ostwald System may wonder why they have not been discussed before. In reality these systems represent forms of materials standards prepared to include the most useful portion of the gamut of surface colors. These materials standards are closely controlled spectrophotometrically by the manufacturers and designations in either of these systems can be transformed into designations in the CIE System discussed in the preceding section. Furthermore in this sort of system the arrangement of colors is orderly and the steps approximate equal visual differences making them useful for the expression of color tolerances. Where the nature of the printed material is such that the surface appearance corresponds closely to that of one of these systems they can be used as satisfactory working standards and for specifying tolerances therefrom. However, since the emphasis in this discussion has been on instrumentation, and since spectrophotometric specifications are more basic physically, it was felt unnecessary to discuss them at length here.

Summary

To sum up then the status of color control, at least insofar as it relates to the converting industry:

1 - Spectrophotometric control is available and can be used for the maintenance of material working standards.

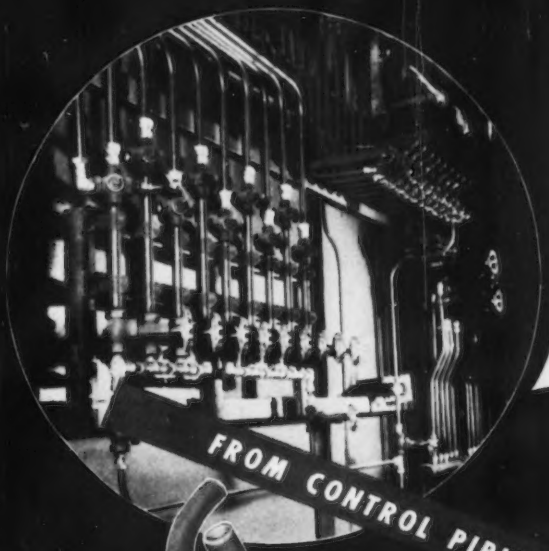
2 - Indirect film thickness control can in many cases be successfully exercised by the use of relatively simple and inexpensive measuring devices called densitometers.

3 - Unequivocal specification of color tolerances is at present somewhat difficult but rapid progress is being made in the development of colorimeters.

Certainly the growing use of color is a basic part of the high standard of living we enjoy. The converting industry—in fact the whole graphic arts industry—is on the threshold of an era where color will be of even greater importance than it is now, and in which technological developments of increasing usefulness may be expected.

WHEN THE PRESSURE IS ON P.P.&E. PIPING

has what it takes



FROM CONTROL PIPING TO STEAM MAIN

Today's 1000°F and higher temperatures, combined with pressures in the 2000 psi range——really "put the pressure" on a piping system. It could be said that these higher, and perhaps even higher pressures to come, will force new standards of piping.

But—remember when 750°F was considered to be a high reheat temperature? Even then, P.P.& E. was ahead of the needs in piping to carry the load. As the trend toward higher temperatures continued—P.P.& E. has kept ahead of the requirements.

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The Role of Printing Plates in Paper Conversion

Ben R. Preston

President, Crescent Electrotype Corp.

The importance of this subject in today's pattern of living, and its profound influence on mankind's development, more than warrants a review of the forces and events that have resulted in the present extensive use of printing plates. This importance gains added significance when it is realized that *90 per cent of all converted paper products reach a printing press at some stage of their production.*

Every day the archeologist's shovel unearths evidence that man has always striven to express himself pictorially. His decorated artifacts, carvings, statuary attests this creative urge in all ages. The cave paintings in France, said to be 30,000 years old, indicate that prehistoric man was moved to pictorial expression. That man wished to give permanence to his thoughts and knowledge as well as to his artistic creations is clearly in evidence also. The baked clay cuneiform tablets of six thousand years ago, the illuminated scrolls sealed in tubes against decay all bespeak this ever present desire of men to pass on the best of their knowledge and culture.

When Gutenberg in 1454 conceived and developed movable type, modern man found his first opportunity to express himself not only in permanent form, but also in *multiple* form. A hundred, a thousand, a million duplicate copies for as many pairs of eyes to see and study! The magnitude and full implications of this invention and its influence on man's development is impossible to assess, for that evaluation could only be made by the last man on earth.

Here at last was a means of mass education; of mass communication; of permanently recording man's accumulated knowledge, his religion, spiritual experiences, culture, science. It is difficult even to determine the full significance of Gutenberg's genius for men of 1953, for who could say what life would have been here today without the world's literature, records, reproductions. Imagine if you can a class in paper conversion sans text and reference books; without charts, graphs and illustrations.

Ben R. Preston is President of the Crescent Electrotype Corp. Battle Creek, Mich. and Vice-President and General Manager Crescent Engraving Co. Kalamazoo, Mich. He is a member of the American Photo-Engravers Assn., International Assn. of Electrotypers and Stereotypers, Electrochemical Society, and Past President of the Kalamazoo Sales Executives Club. He is presently serving on Technical Advisory Committee of International Assn. of Electrotypers and Stereotypers for the development of improved processes of electrotyping.

He entered the Graphic Arts Industry in 1916 as apprentice photo-engraver. He was in Naval aviation First World War from 1917, 19 subsequently finishing apprenticeship and becoming journeyman photo-engraver working in offset, gravure and letterpress plate making.

He originated and perfected application of tin plating in electrotyping process, now in general use throughout the industry. In collaboration since 1939 with Homer Bishop of Dayton, inventor of the modern Bishop method of pre-makeready of electrotypes, he perfected this process for the printing of carton board.

Prior to the last half of the 19th century, illustrations were printed from hand cut plates engraved in wood, metal or stone. While there exist many very beautiful specimens of this type, each such illusration was entirely dependent on the artistry and hand craftsman ship of the individual engraver. Actual fidelity to the original scene or object had to be left entirely to the ability and imagination of the engraver. Further, such printing plates were costly and time consuming to make, and could not therefore be produced in volume and in multiples as required for volume printing production.

It remained for the discovery of photography and its application to plate making, to bring about a photo-mechanical method of engraving. This development resulted in accurate and faithful reproductions, produced quickly and in volume. With the development of high speed presses and relatively inexpensive and high quality printing plates, paper conversion came of age. The subsequent discovery of color photography and the adaptation of this principle to the making of multi-color printing plates gave the final impetus to printing that has resulted in the tremendous volume of converted paper and paper products that we see today wherever we may turn.

Before entering into a technical discussion of printing plates we should clearly recognize another force that has had a tremendous impact on volume of printed products. This influence has developed largely in this century and is unquestionably responsible for a very substantial percentage of present day conversion. Our national publications, periodicals, magazines and newspapers could not exist without the revenue from paid advertising. It has been truly said that the price of a Saturday Evening Post does not cover the actual cost of the paper involved. Nor should we fail to recog-

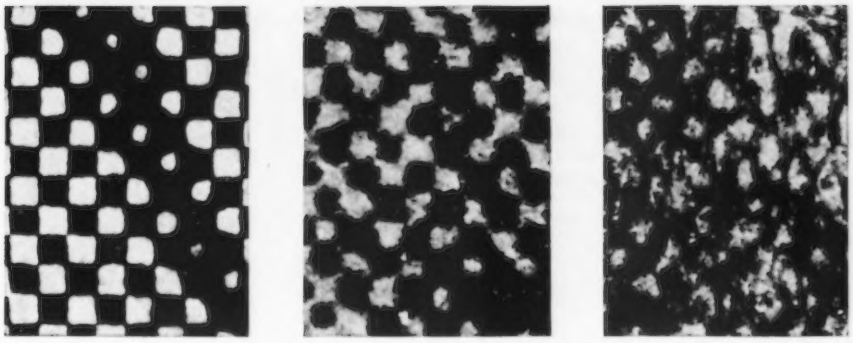


Fig. 1 The fundamental differences in printing plates and printed results

Left to right. Enlargement of impressions obtained from relief, planographic and intaglio plates, by letterpress, offset and rotogravure printing processes.

nize that modern packaging, which in itself accounts for untold tons of converted paper, is distinctly a form of advertising. Can labels, bread wrappers and cartons of all kinds and description fall within this category.

It is reported that 76 percent of America's 37 billion dollar food bill consumed in 1951 was sold to the consumer via the master market or self service store. In this kind of merchandising the package becomes the salesman. Surveys have shown that two thirds of the consumers patronizing these stores make their choice of brands *at the point of sale*. Obviously the design, choice of colors, eye and appetite appeal of the printed carton or container has much to do with this choice. It should also be noted that the large national food packers change these package designs frequently, and accompany these changes with supporting newspaper, magazine, car card and poster advertising, all of which requires more paper, more printing and more printing plates.

Thus we see that man's inherent instinct; to express himself in permanent and multiple form, to perpetuate his ideas, his culture, his religious, philosophical and scientific experiences, to entertain himself and to sell his merchandise; has resulted in an industry of gigantic proportions, an industry that without printing plates could not exist.

Technical Discussion

There are three major types of printing, each requiring a distinctly different kind of printing plate. Altho these plates differ considerably in appearance and preparation, and the means of transferring ink to paper differs in each case, fundamentally they each utilize identical sciences; each is initiated by a photographic process; each employs optics, photography, chemistry and mechanics to arrive at their separate ends, bonding these elements into a composite science by a very high order of craftsmanship. We shall rather briefly consider the mechanics of two, and discuss in greater detail the third which accounts for approximately 70 percent of all printed products.

Gravure

Gravure printing utilizes an "intaglio" printing plate, meaning that the actual engraved image is *into* or below the surface of the plate. Steel etchings, copperplate engraving, dies used to print our paper money employ this principle of printing. The engraved-in areas of an intaglio plate are filled with ink, the non-printing upper surface of the plate cleaned of all ink, and the paper then applied under pressure. The ink in these recessed areas adheres to the paper and is literally lifted out of the engraved design.

The gravure process responsible for the heaviest volume of this type of printing is properly called "rotary photogravure," implying that the plate is produced by the aid of photography and the printing is done from a rotating cylinder (the plate). This type of gravure printing depends for its gradation of tonal values on the variable depths of the engraved-in image or design, which variable depths transfer variable thicknesses of ink to the paper. The thicker areas of ink will, of course, appear as the dark shadows of the illustration, and the thinner deposits of ink will be the bright or hilits areas. The reader will probably be most familiar with gravure printing through the "roto" sections of many Sunday papers, although this process is also used extensively in many other areas of printing production.

It is this feature of using variable thicknesses of ink to reproduce the many light and shadow tones of a photo or illustration that gives gravure one of its characteristics. Because of this feature, gravure is capable of achieving extreme contrasts, and a greater "range" of tones than either of the other two. Another characteristic of gravure is a fine "feathering" or raggedness along the edges of type matter. In this respect either of the other two is superior.

Another advantage of gravure is extremely high speed production. Usually a "web" or continuous roll of paper is fed into the press, and because of the high volatility of the ink vehicles and consequent rapidity of drying, the web may travel at very high speeds and be re-wound without danger of "offset" or transfer from a still wet impression of ink. In fact a modern newspaper gravure press will take a web of paper at one end and deliver complete roto sections at the other end, printed both sides, slit, trimmed, assembled, folded and stacked at a speed that is astonishing to watch.

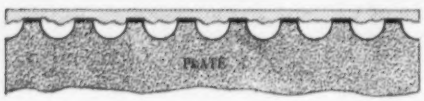
Lithography

This process of printing, known also as photo-lithography, offset lithography or planographic printing, dates back to the middle years of the last century. Alois Senefelder of Munich, quite by accident rather than design, stumbled onto the basic principle. Having no better medium available at the moment, he wrote out a laundry list with greasy ink on the surface of a flat polished stone. Sometime later when he washed the writing off the stone, he discovered the grease from his ink had penetrated into the grain of the stone immediately under his writing. By moistening the stone he was able to re-apply a coating of ink to the greasy areas while repelling it from the balance of the moist surface. The affinity of a greasy ink for a greasy surface and the antipathy of this same greasy ink for a moist surface thus led to the first lithographic printing, and is indeed the basic principle of modern planographic printing as practiced today.

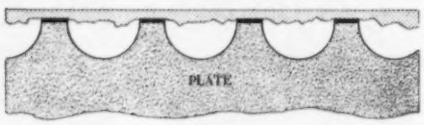
For the first fifty years after its discovery, lithography was almost exclusively a tool of the artist. He could make his original drawing on a prepared stone surface, and they print as many duplicates as desired direct from his original drawing. While giving the artist almost infinite control over the reproduction of his creations, the process was too slow to have much commercial value, and, except for highly specialized work, has given way

Cross-section of 120 line halftone impression on coated paper. Smooth surface takes ink from top of dots only.

Cross-section of 120 line halftone printed on rough surface paper. Some dots do not leave full impression.



Cross-section of 120 line halftone sufficiently squeezed into rough paper to take ink from all dots. Spreads the ink and produces muddy printing.



Cross-section of 65 line halftone printed on rough paper. Increased space between dots permits of greater depth and prevents muddy tones.

Fig. 2. How the halftone prints.

to photo-lithography or "offset" as we know it today.

The modern process utilizes a thin sheet of zinc or aluminum in place of stone, and the illustration or type matter is photographed onto these sheets, which photographic image is given a greasy surface while the surrounding areas of metal are bare and receptive to moisture. These flexible sheets are drawn or wrapped around a cylinder of the printing press where first they come in contact with a moisture roll, then with an inking roll. The ink is repelled from the moist areas of bare metal but a film of ink is deposited on the greasy areas of the design. In a modern litho press, this inked image is then printed or "offset" onto a rubber surface from which it is finally transferred to the paper.

Offset lithography finds its principal application in the reproduction of art subjects, calendars, maps, advertising broadsides, billboards, greeting cards, office forms, can labels and the printing of sheet metal for cans, although it accounts for a considerable volume in many other fields of printing. The latest government figures available credit lithography with about 20 per cent in dollar value of all printing production in the U.S.A.

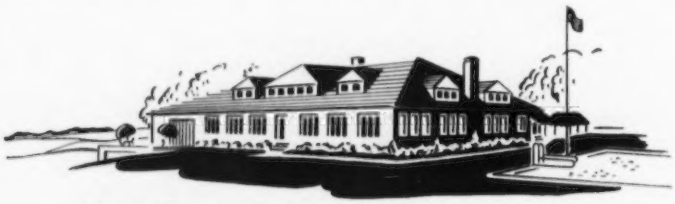


Fig 3. Reproduction of a line engraving.

The advantages of lithography are many. Because of the cushioning effect of the rubber surface from which the final transfer is made, offset successfully prints on rough or textured surfaces where either of the other processe would fail. As the printing surface is an unrelieved plane, many of the mechanical problems inherent in the other processes are eliminated, and because of this freedom from some mechanical limitations, offset achieves extreme delicacy and softness of tone and detail.

This characteristic softness plus the nature of offset inks, usually dull and lusterless, does not recommend the process where brilliance and depth of color is required. However much progress has been made recently, both in the preparation of the plates and compounding of inks, in giving offset printing greater depth and higher luster.

Letterpress

Also referred to as relief printing, letterpress was not only the original printing method, but remains today the most universally used process of committing ink to paper, and accounts for probably 70 per cent of all printing in the U.S.A. Capable of greater flexibility, higher fidelity of reproduction, extreme brilliance and high luster, letterpress (See Figure 1) is adaptable to a wider range of printing requirements than either gravure or lithography. In this process the printing surfaces are in "relief" or raised above the non printing areas, the paper com-

Photoengraving of a portrait without the use of the halftone screen. Only two tones — black and white—are possible.

The halftone screen which enables the photoengraver to reproduce all tones of a copy from black to white.

Reproduction of the same portrait by use of the halftone screen, re-creating all lights and shades of the original.

Fig. 4. How a "screen" produces the halftone.

PENFORD GUMS

(Starch hydroxy ethyl ethers)

(U.S. Pat. #2,516,632, #2,516,633, and #2,516,634)

The use of Penford Gums is rapidly and widely expanding in the Paper Industry. The unusual properties of these gums as outlined below offer new and substantial advantages for calender size, size press and tub size, coating and beater addition and other paper processing.

CALENDER SIZE

To Increase Mullen, Penford Gum 280, a high fluidity starch ether is used in concentrations of from 6% to 8% solids at a temperature of 190°F. This calender application greatly increases mullen on all types of board. An average consumption is about 8# to 15# Penford Gum 280 per ton of 16 point board.

For High Gloss Ink Printing And Reducing The Penetration Of Wax, Oil, Glue, And Other Finishing Agents, the medium fluidity starch ethers such as Penford Gum 240, 250 and 260 are used. When these products are used respectively in a 4%, 5% and 6% concentration at a temperature of 130°F to 140°F, a proper finish for high gloss ink printing is developed. The results are comparable or superior to much costlier finishing agents.

For Eliminating Fuzz And Controlling Density, the low fluidity starch ethers, Penford Gum 200 and Penford Gum 240 are used. Due to their high viscosity and resultant non-penetrating properties, these products are used at concentrations as low as 1½% solids and at low temperatures.

SIZE PRESS AND TUB SIZE

The Surface may be sealed by using the surface sealing, viscous Penford Gums, or mullen and fold may be increased by using the thinner Penford Gums.

COATING

As a Coating Adhesive Penford Gum 280 is used by itself or with resins for medium-high concentration machine coatings. All Penford Gums are extremely reactive with urea formaldehyde resins and produce high pick coatings. Penford Gums 250, 260, 270 and 280 are used alone or with latex emulsions in smooth pigmented size press coatings. Coating weights from 4 to 13 pounds per ream are being produced, and these coating formulations may be water-finished on calenders if desired. The pigment may vary from clay to all titanium dioxide.

BEATER

For beater addition, the Penford Gum 200 may be used either cooked or raw. Because of the lower gelatinization temperatures of the Penford Gums, the raw starch will swell and gelatinize in many sheets as they are formed.

Write us for our recommendations on the particular grade of Penford Gum best suited for your specific operation.

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Fig. 5 This enlargement shows the characteristic details of halftone printing

ing into direct contact with these raised areas and picking up the film of ink that has been laid upon them. (See Figure 2).

Printing plates employed in letterpress are called photoengravings, and as the name implies, are produced with the aid of photography. We must therefore start the making of a photoengraving with something that can be reproduced by photography. Artist drawings, portraits, snapshorts, prints of type matter, anything that lends itself to photographic copying is suitable, and is referred to as "copy."

Where the copy may be a pen and ink drawing or a type proof, only the simplest engraving is required. Called a "line" engraving, this plate prints only one value of color, a relatively unbroken solid covering relatively large areas of the paper such as shown in Figure 3. With the reproduction of portraits, wash drawings and other copy where tones run the full gamut of color values from solids thru the multitude of intermediate greys to clear whites, the process becomes much more involved.

Such plates are called "halftones," and are accomplished by interposing a "halftone screen" (Figure 4) between the copy and the sensitized film on which the copy image is being photographed. This screen is a glass in which there are alternate areas of opacity and transparency, and its function is to break up the continuous tones of the copy into minute dots in the photographic negative, each dot of such a size that it truly reproduces the tonal value or density of that small area of the copy which it represents.

Each of the transparent areas of the halftone screen acts as a miniature camera lens, and each of these tiny lenses "sees" and reproduces its own tiny area of the copy, interpreting the depth of color of this area in terms of *size* rather than in chroma density of ink that wil subsequently be transferred to paper. It is important to remember this, and to realize that a halftone reproduction is in reality a multitude of tiny individual printing plates, each printing an identically thick layer of ink, and differing one from the other only in their respective sizes. This characteristic of halftone printing is clearly illustrated in *Figure* 5. If the reader will observe this illustration from a distance of about ten feet, then slowly approach it to normal reading distance, the principle of halftone reproduction will be immediately apparent. This test will also serve to demonstrate that a halftone is something of an optical illusion, fooling the eye into seeing varying tones of black, grey and white instead of individual tiny areas of solid color that actually compose the plate. This illusion is accomplished by using screens of such fineness that the eye fails to distinguish the individual dots, and may roughly be compared to motion pictures where sixteen still pictures per second are projected on the screen, a speed too fast for the eye to register each picture as an individual.

In letterpress printing it is axiomatic and mechanically necessary that the fineness of the halftone screen be chosen to satisfy the relative roughness or smoothness of the paper to be printed—the smoother the paper the finer the screen. (See *Figure* 6). Halftone screens in common use (*Figure* 7) today start with 50 lines to the inch, usually employed for newspaper printing, then graduate thru 55, 60, 75, 85, 100, 110, 120, 133, and 150 lines per inch, which finer screens are used for printing on the finest clay coated papers.

In examining Figure 7 note carefully the increasing clarity of detail and definition with each increase in the number of lines per inch. This points up another axiom of halftone printing —the finer the screen the better will be the resultant reproduction. However true this may be, it should be remembered that the surface finish of the pa-

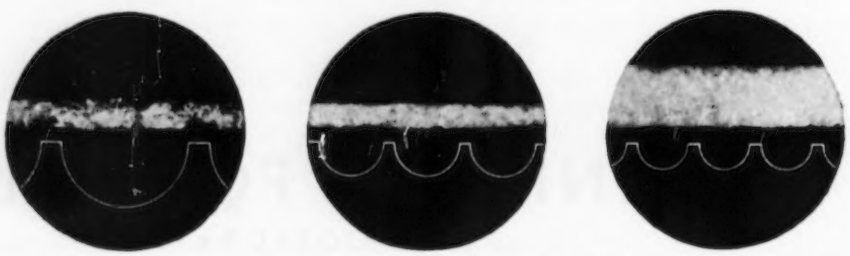


Fig. 6 Selecting halftone screen ruling to suit the paper upon which the plate will be printed

To obtain best printed results, each dot requires a smooth flat area upon which to transfer its deposit of ink. The enlargements (50 diameters) show the edges of three different papers and the outlines of halftone dots suited to each. Left to right: Newsprint—coarse screen; Super, Machine Finish—medium screen; Heavy Coated—fine screen.

133 LINE SCREEN
For printing on coated paper.

120 LINE SCREEN
For magazines and dull coated papers.

100 LINE SCREEN
For machine finish, super and bond.

85 LINE SCREEN
For blotters, colored bonds and high-grade newsprint.

65 LINE SCREEN
For average quality newsprint.

50 LINE SCREEN
For national newspaper advertising campaigns.

Halftone Screens in General Use

per must determine the screen value to be used. To use a screen finer than the paper can successfully accept is to invite printing difficulties out of all proportion to the gain in detail effected with the finer screen.

As the lines of a halftone screen run in each direction at right angles, it will be seen that the number of dots per square inch will be the square of the number of lines per inch. A little arithmetic will disclose that each square inch of a 120 line halftone contains 14,400 individual dots. In the printing of color illustrations, where generally four colors are printed one over the other, we will therefore find 57,600 dots in each square inch of printing. These figures will bring into sharp focus the task presented to the photoengraver, the skill and craftsmanship that he is called upon to exercise when making a halftone plate. He must rigidly control the size of each one of this multitude of dots, smaller than the naked eye can distinguish, to satisfactorily reproduce the copy.

Line engravings and course screen halftones are usually made on sheet zinc about one sixteenth inch thick. Extremely fine line engravings and fine screen halftones are made on sheet copper of a similar thickness. After the copy is photographed into negative form on the engravers camera (see Figure 8), the negatives so obtained are used to photographically print onto these methal sheets which have been prepared and sensitized with a light sensitive solution. This operation is very similar to the procedure followed in making snapshot prints from the negatives made in your hand cameras. Thus each line or dot is photo-impressed on the metal, utilizing chemicals that will protect the metal immediately under these lines or dots from the etching mordant in the subsequent processing.

By two photographic steps we now have a sheet of metal bearing an acid impervious image of the copy. In the etching process, the spaces and areas between and around each dot or line are chemically removed, leaving the image in relief. See *Figures 2 and 6.* Here the engraver is faced with his most exacting problem—to secure sufficient depth between each dot or line so there will be no possibility of ink filling up the interstices in the printing operation, while at the same time maintaining infinite control of the size of each dot and line. Many steps of finishing, machine work, proofing and inspection follow the etching process, but but the purpose of this paper it will not be necessary to enter into a detailed discussion of these finishing operations.

We have attempted here to outline rather than detail the process of photoengraving. Anyone who may require or desire a more intimate knowledge of the many steps and techniques that go into the making of a finished plate, should visit a photoengraving establishment. There are over 600 such plants in the United States and visitors are always welcome.

Undoubtedly many attending these classes in paper conversion will, in their future work, be in positions re-

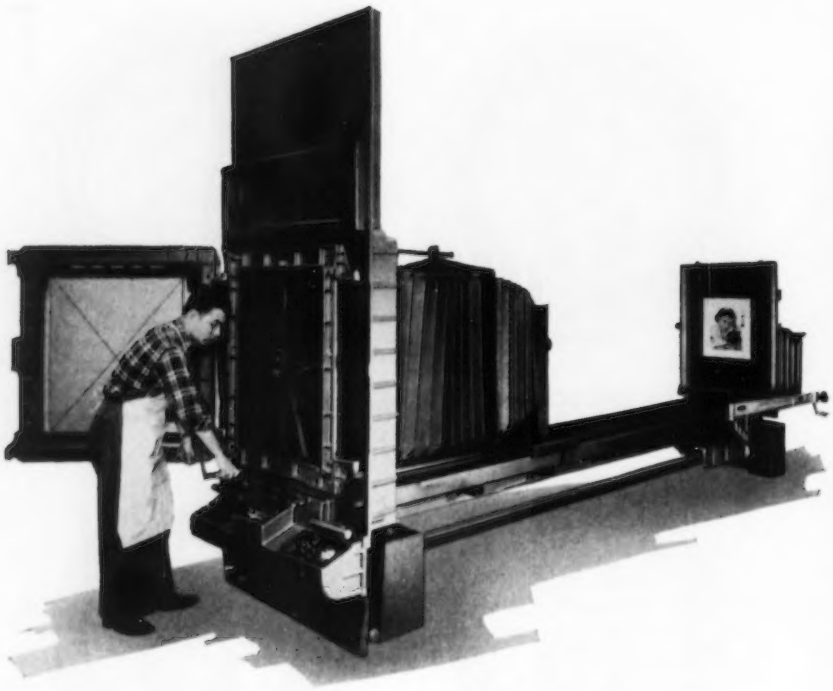


Fig. 8 Modern Photoengraving Precision Camera for Monotone and Color Reproduction.

quiring the specification of, ordering or judging of printing plates, and to you a few do's and don'ts are very much in order. Remember first, it is a photographic process. If the copy, whether it be artist's drawing, photo print or type proof, is not exactly what you will require in finished printing, don't expect miracles from your engraver. His camera will only reproduce what the camera lens is able to see in the copy. A good engraver can do wonders with bad copy, but there are definite limits beyond which he cannot go.

Recall again that a halftone is in reality only an illusion of a continuous printed surface. Your engraver utilizes only about half the total surface of paper, the other half being the white of the paper showing between the dots. With his half, the engraver must try to accomplish what the drawing or photo does using 100 per cent of the surface—often an impossible assignment. From this the origin of the term "halftone" is easily understood.

An artist preparing a colored illustration may employ as many as two dozen separate tubes of color, each a different color, shade or hue. In the usual printing plates made from this illustration, the engraver is limited to the use of four colors, red, yellow, blue and black. It is only by controlling the dot sizes in his plates that the engraver attempts to simulate the myriad nuances of shade and color values that the artist has effected with his multitude of color tubes. Add to this the fact that the surface of the printed sheet differs from the artist's drawing board; the chroma density and reflective index of printing inks differ radically from artists' colors; that usually the size of the reproduction differs from the size of the drawing. Clearly the engraver, under these conditions, has a monumental task. Again, don't expect miracles.

Finally, your engraver has no inventory of finished plates from which to fill your order. Each job he produces is custom built and tailor made from scratch to meet your individual specifications. While part of his work is photographic and mechanical, much of it depends on hand craftsmanship. When he is faced with unreasonable demands for fast deliveries, something must suffer. As his photographic and mechanical operations are standardized and therefore irreducible as to time consumed, the only reducible time left is that which is usually devoted to craftsmanship. Your engraver is the only one qualified to say how much time should be required for the production of a first class job. If you demand delivery in less time, you are not entitled to expect perfection, for you have forced him to reduce the one ingredient that assures perfection — his craftsmanship.

Electrotypes

No discussion of letterpress printing could be complete without mention of electrotypes. Except in the smaller job printing shops, most printing plants use large presses requiring jobs to be printed in multiples, often as many as twenty or more impressions of identical subjects at each revolution of the press. To make this many identical engravings would be prohibitive in both time and cost. Where such duplication of subject matter is required, the photoengraving serves not as the ultimate printing plate, but as a pattern from which the final printing plates are made. Much as a molder uses his master pattern from which to make molds and castings, so the electrotyper uses the master engraving to make as many electrotypes as may be required, quickly and inexpensively.

A lengthy discussion of the process of electrotyping is unnecessary for our purpose. Suffice to say it is a process of molding; electro deposition on this mold of nickel, copper or chrome for the printing surfaces; the casting of molten lead alloy behind these printing surfaces; of various finishing and machine operations; the result being a duplicate of the master engraving.

These electrotypes are made flat or may be curved to fit the plate cylinders of rotary presses. The bulk of heavy production printing today: newspapers, magazines, breadwrappers, cartons and most printing requiring long runs, are printed on rotary presses, to which the paper may be either sheet fed or web fed. Speed is the essence of today's printing production, and rotary presses are capable of production speeds several times faster than flat bed presses.

Fabrication of Corrugated Shipping Containers

Norman W. Garrison, Jr.
Eddy Paper Corp.

The subject for discussion is the fabrication of corrugated shipping containers. It is a broad subject and I will of necessity limit it and center it around the type of operations performed at our Three Rivers plant.

We start out with the materials used in the manufacture of corrugated containers. The liners for the inside and the outside are usually of fourdrinier kraft; cylinder kraft and jute are also used but to a lesser extent. The liners may have dry finish both sides, water finish both sides or dry finish one side water finish the other. A partial list of the various corrugating mediums would consist of fourdrinier kraft, cylinder kraft, semi-chemical, strawboard and bogus. The weights of the liners range from 33 lbs. to 90 lbs. per M sq. ft. for kraft, correspondingly higher for jute. The weights of corrugating medium range from 26 lbs. to 32 lbs. M sq. ft.

The liner combinations used in fabricating a container are of course governed by the articles the container is designed to carry. Rule 41 of the Consolidated Freight Classification is the "bible" governing the requirements of a box performancewise. The rule is enforced by the Carriers and the Interstate Commerce Commission. As an example, a 200 lb. test container, that is, a board combination that will withstand a bursting test on a mullen tester of 200 lbs. per sq. in., has a size limitation of 75 inches (inside dimension length plus width plus depth) and a limitation of the gross weight carried of 65 lbs. The larger the size and

Norman W. Garrison, Jr., is a native of Three Rivers, Mich. After five years in the armed forces, where he holds the rank of Captain in the Air Force Reserve, he became associated with the Eddy Paper Corp. in Three Rivers, in 1947. His present position is that of Quality Control Supervisor.

weight of the articles to be carried the more strength the box must have. Thus all test boxes carry the manufacturers' guarantee stamp, showing firm name, address, bursting strength, size and weight limitation.

The bursting strength of combined board is determined by adding the bursting strength of the inner and outer liner plus 30 lbs. for the corrugating medium.

Manufacturing Equipment Used

Let us start with the operations necessary to fabricate a corrugated container. The heart of any box shop is the corrugator — the machine on which the board is formed. A modern corrugator is an intricate and expensive piece of machinery. The most prominent manufacturers are the Samuel M. Langston Co., the Geo. Swift Co., the S&S Corrugated Machinery Co. and the F. X. Hooper Co. We have at Three Rivers one of the largest corrugators in the industry, a 105 inch wide Langston machine, capable of running over 500 linear feet per minute producing over 50 million sq. ft. of board a month.

The sequence of operations on the machine is as follows: First the inner liner is placed in a roll stand, threaded over a preheater to make it susceptible to mositure and into the single facer. The roll of corrugating medium is

STANDARD BOARD COMBINATIONS

Mullen Test Req'd. Lbs. per Sq. In.	Outer Liner Wt. per M Sq. Ft.	Mullen Test	Inner Liner Wt. per M Sq. Ft.	Mullen Test	Corr. Med.	Mullen Test	Total Mullen
125	33 Kraft	85	33 Kraft	85	Semi-Chem.	30	200
175	42 Kraft	100	33 Kraft	85	Semi-Chem.	30	215
200	42 Kraft	100	42 Kraft	100	Semi-Chem.	30	230
250	69 Kraft	145	42 Kraft	100	Semi-Chem.	30	275
275	69 Kraft	145	69 Kraft	145	Semi-Chem.	30	320
350	90 Kraft	175	90 Kraft	175	Semi-Chem.	30	380

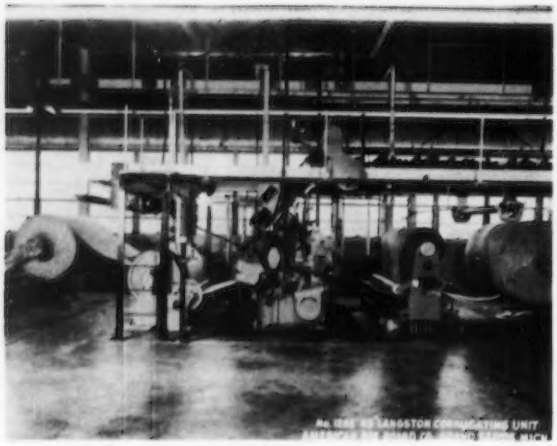


Fig. 1. Corrugator single face installation.

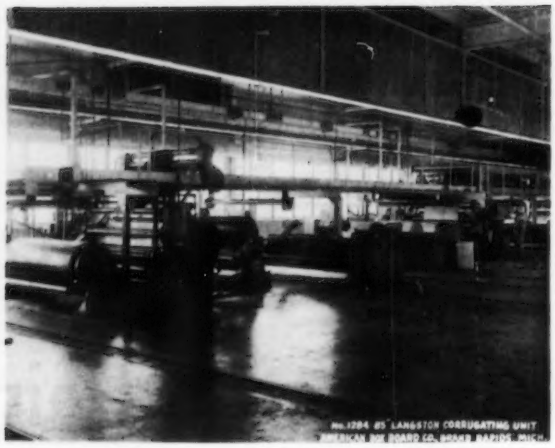


Fig. 2. Corrugator bridge installation.

placed in a roll stand, threaded over a preheater and series of steam showers and into the single facer from the opposite side. The corrugating medium passes between two fluted rolls that mesh to form the flutes, fingers spaced in the corrugating rolls fluff the sheet from the corrugating rolls where it contacts a transfer roll that applies adhesive to the tips of the flutes. It is then joined to the inner liner, forming what is known as singleface board. The singleface board is conveyed over a bridge to the doublebacker where it passes over a transfer roll that applies adhesive to the exposed tips of the flutes. The outer liner roll placed in a roll stand, threaded over a preheater and into the doublebacker, is joined to the singleface board, forming a three ply board. This double faced board then travels over a heating plate section being conveyed between wide cotton belts which keep the board under a slight pressure and allow time for the adhesive to set. As the board leaves the belt section, it travels through a slitting and scoring attachment and finally to the cutoff, thus producing sheets trimmed for length and width and scored lengthwise.

A three bar scoring and slitting attachment allows multiple setups for various box blank sizes with a minimum of machine downtime. By pressing a button, one bar turns down and the next bar with scoring and slitting heads previously set in place, moves up. A double cutoff and double sheet delivery station also allows more flexibility in running various sizes of box blanks.

Most modern corrugators have two single facer stations either in series or double decked; with two bridges and two adhesive stations at the doublebacker a five ply or doublewall board may be fabricated.

The two most common types of corrugated board are A flute and B flute, the difference in the designation of flutes being only in the depth between grooves and ridges of the corrugating material. A flute will caliper approximately 3/16", B flute approximately 1/8". C flute was designed as a substitute for both and falls in between. There is also a jumbo flute used for inner packing which calipers approximately 1/2". The doublewall combinations therefore depend on the singleface installations and may be of the following AB, BC, CC or AA.

The contents of the container determines the flute used. As an example A flute provides a greater cushion, B flute is used on can boxes where the contents provide support in stacking and a tight fit is necessary to keep the cans from jarring about in the container.

The two most common adhesives used on a corrugator are silicate and starch. There are arguments among manufacturers as to the relative merits. We use silicate on the singlefacer and starch on the doublebacker. Silicate forms a harder bond but has a tendency to build up on the equipment. It must then be scraped off. Starch takes on a powder form when dry and crumbles under friction, reducing wear on belts and causing less clean-up time.

The formation of the box blank

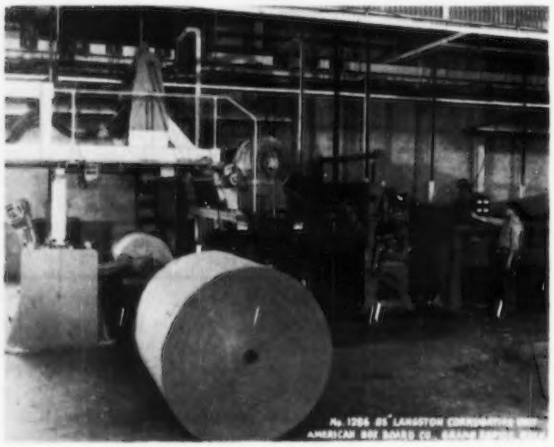


Fig. 3. Corrugator doublebacker installation.

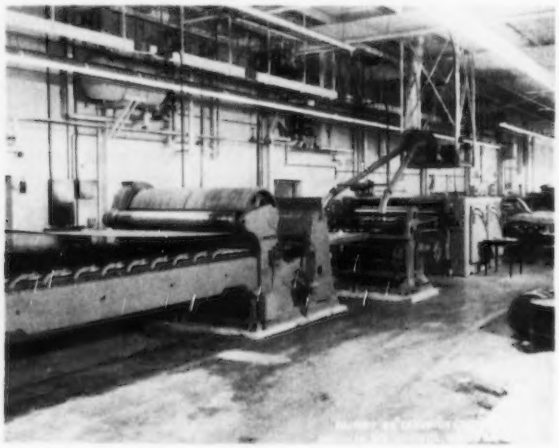


Fig. 4. Corrugator hot plate section, slitting, scoring, and cutoff sections.

Fig. 5. Corrugator, box blank takeoff.

has been covered. We will now take up the operations necessary to fabricate regular slotted containers, which incidentally comprise about 80 to 90 per cent of the volume of the container industry.

Fabricating Regular Slotted Containers

The corrugated printer-slotter provides the means for printing, creasing and slotting the box blank. The machine is hopper fed permitting high speed operation. Each handful of blanks is placed between adjustable stopper plates keeping the piled sheets even and squared. A kicker working back and forth under the pile picks the bottom sheet and pushes it forward to a set of pull rolls. When the forward motion is taken up by the pull rolls, the kicker retrogresses for the next sheet. The pull rolls convey the sheet under the first printing cylinder. The printing cylinder is of wooden composition marked off in inch squares for the aligning of the rubber printing dies so that they will contact the box blank according to specifications. The individual panel dies are mounted beforehand on a fibre sheet, the sheet is stapled to the wooden cylinder. As the inked surface of the die strikes the sheet, the ink is transferred to the surface of the sheet. A second set of pull rolls between the first and second printing cylinder keeps a constant pull on the sheet at a constant speed. The first press is used only for the lighter shade of two inks. If the specifications call for only one color, the ink is applied at the second press. Ink is worked down to the printing cylinders from their respective ink fountains. The fountains extend the full width of the machine with a pressure blade at the base resting against the bottom of the fountain roll. The pressure blade can be set by a series of thumb screws against the fountain roll, allowing a measured quantity of ink to be carried through as the fountain roll rotates. Through a series of ductor rolls, distributor and oscillating rolls, the ink is thoroughly worked

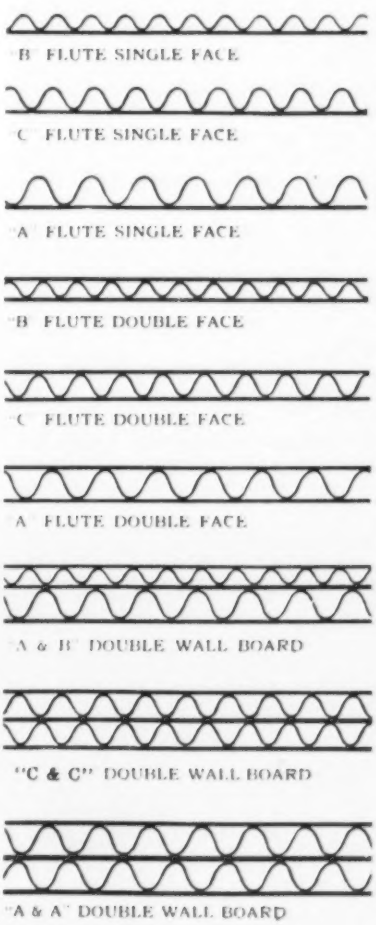

"B" FLUTE SINGLE FACE
"C" FLUTE SINGLE FACE
"A" FLUTE SINGLE FACE
"B" FLUTE DOUBLE FACE
"C" FLUTE DOUBLE FACE
"A" FLUTE DOUBLE FACE
"A & B" DOUBLE WALL BOARD
"C & C" DOUBLE WALL BOARD
"A & A" DOUBLE WALL BOARD

Fig. 6. Types and combinations of flutes.

and spread over form rolls which contact the dies. The box blank emerging from under the second printing cylinder enters the creasing and slotting mechanism where creases are placed in the blank and slots are cut to form the flaps. The box blanks printed, creased, trimmed and slotted, drop on a slow moving conveyor belt shingle then drop on a take-off table where they are picked up in handfuls and stacked in loads ready for the next operation.

There are several manufacturers of printer-slotters. They all perform the same operations but in a different order, some for example have the creasing operation between printing cylinders. We use the Langston type as illustrated.

We now come to the closure of the regular slotted container. The two most common types are taping and stitching. We will first discuss taping as accomplished on a semi-automatic machine. Box blanks in piles are placed on a roller conveyor and automatic lift which keeps the box blank entering the mechanism always at the level of the throat of the taper. The operator folds the box blank and pushes it forward where pull rolls take over guiding the box through the operation. The tape in rolls pre-gummed is pulled over a wetting roll, or ungummed tape is pulled over an adhesive roll. The tape is placed along the depth of the box and is cut to length by trip operated solenoid switches. The box blank is then guided along between belts and pressure applied to set the adhesive. The boxes drop into a counter ejector set to eject the required number of boxes in stacks along a roller conveyor where they are bundled.

There are also automatic tapers, hopper fed that fold the flaps. They of course have size limitations.

The tapes run 2, 2½ and 3 inches in width, the application depending on size and contents of the container and of course conforming to Rule 41. Some of the tapes available are kraft paper tape in weights ranging from 40 to 120 lbs., kraft backed combined with asphalt and sisal fibres, kraft backed combined with glass fibres, cloth backed tapes in different weights, clay filled cloth and others.

The stitched box has a flap that laps not less than 1¼ inches and is fastened with metal staples or stitches not more than 2½ inches apart. The stitching machines that are used to accomplish this type of joint comprise in their simplest form a stitching head, a clinching anvil, a frame to hold these parts in their proper positions, and the mechanism which provides motion to the stitching hand. A single rotary action, in proper sequence feeds the correct amount of wire, cuts it off,

forms, drives and clinches the staple. There are many types of stitching equipment designed to accommodate various sizes and shapes of containers. Some are fully automatic, semi-automatic or manually operated.

The bar stitcher has an exceptionally long throat to handle outsize containers. The operator folds the blank, placing the panel over the stitch flap on the anvil, then trips the stitching mechanism by a foot pedal, spacing staples along the depth dimension.

Table stitchers are used for normal size containers, have a throat entry that lines up the stitch flap and adjacent panel, making it a faster operation even though the stitchers are placed by actuating a foot pedal.

Semi-automatic stitchers have a lift conveyor that keeps the blanks at the level of the throat entry. The operator folds the blank and inserts it into the throat of the machine where pull rolls take over and a pre-determined number of stitches are placed automatically by the machine.

The fully automatic stitching machine is hopper fed with a folding attachment. Some machines are also equipped with a slitting, slotting and creasing mechanism in conjunction. Machines of this type stitch as many as 6000 containers an hour.

Another type of closure is the quad, so-called because it has four rigid corners. The box blank has five panels, the closure is off center in one panel, the paper tape is applied both inside and outside, and extends the depth of the panel and both flaps.

The newest type of closure is the glued lap. The operation can be performed on a fully automatic machine at very high speeds. It can also be accomplished on a semi-automatic taping machine with modifications. The flap is similar to the flap on stitched containers except that it extends two inches or more on both the top and bottom box flaps. Weatherproof adhesive is applied by a roller applicator, the containers are shingled coming out of the machine between conveyor belts with pressure applied, allowing time for the adhesive to set. The advantages are an exceptionally strong joint and because the flap and portion of the adjacent panel are crushed, the containers lay flat in bundles, take up less space and warehouse easier.

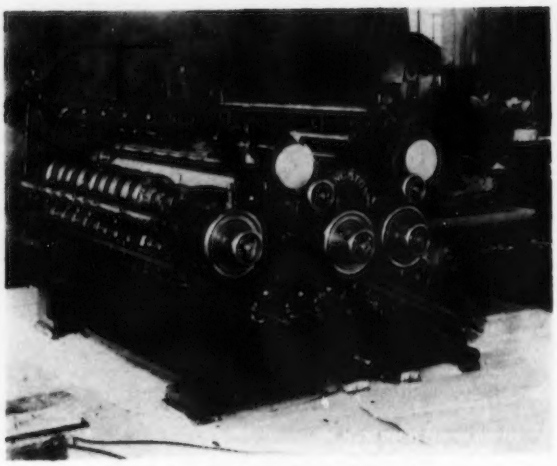


Fig. 7. Corrugated printer slotter.

Now for outsize containers, small containers, small quantity orders and specialties, there are various hand operations whereby containers can be fabricated. Slitters, slotters, bar creasers, band saws are used thus eliminating the longer setup time required for automatic equipment. Stock sheets are run on the corrugator and used for this purpose as well as for inner parts.

The design of some containers specify that the inner flaps must also meet. This means that the blank, if the box is not of equal length and width, has to pass through a flap cutter which cuts the side flaps so they will not overlap but meet at the center the same as the end flaps. There are other variations of flap cutting according to the desired flap arrangement.

Other machines for special design containers are the offset creaser which performs the operation the name implies. As an example on doublewall containers where ordinary creases do not allow the flaps to fold properly, an offset crease placed on the long way flaps will give the proper allowance. A corner cut attachment on a slotter will perform the operations necessary to make a bookwrap. These are paraffin machines that apply coatings to either the inside, outside or both sides of the containers that are used chiefly for meat packaging and more recently by the automotive parts industry to protect metal surfaces from scratches.

Other special design containers are fabricated on die cutters. Metal creasing bars and cutting knives are imbedded in a plywood base, sponge rubber cut in small rectangular pieces is placed along either side of the metal to spring the sheet loose after pres-

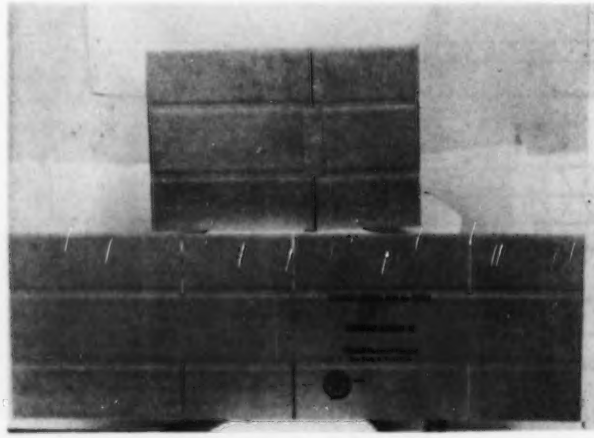


Fig. 8. Corrugated taped box blank.

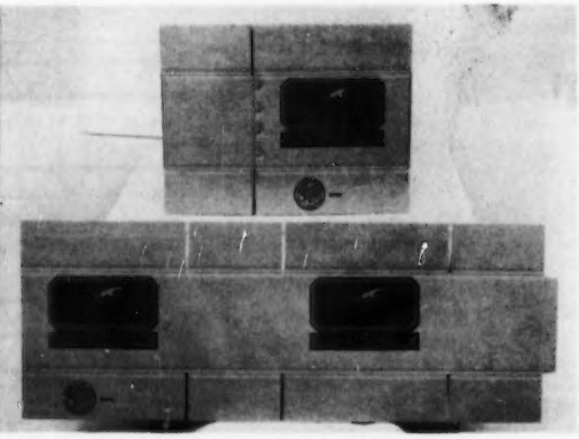


Fig. 9. Corrugated stitched box blank.

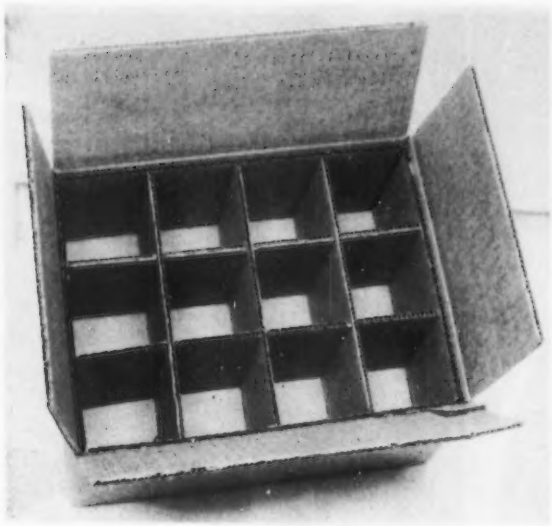


Fig. 10. Corrugated box with inner packing.

sure has been applied to cut and crease the blank. There are several makes of die cutters. On the Thomson platen press, the sheet is fed and removed by hand. On the Cottrell and Miehle presses the blank is secured to grips at the top of a cylinder, the cylinder revolves and the blank contacts the die on a moving platform beneath the cylinder during the revolving motion, the platform then reverses to meet the next revolution of the cylinder. On the Sheridan die-cutter, the blank is fed into the grips of a chase which pulls the sheet over the die on the bottom platen, pressure is exerted, the chase then carries the finished sheet out to conveyor belts; the case then reverses for the next sheet. Die cutters vary in size. Our Sheridan press has a maximum limitation of 63″ x 78″ which allows as many as five beer cases to be die-cut from a single blank.

Corrugated partitions are fabricated on a partition slotter, a hopper fed machine that trims and slots. Nesting or setting up of partitions is still a hand operation in many plants but there are automatic partition assembling machines available. Other types of inner packing are top and bottom pads, side and end liners, creased sheets, gideons or glued built up pads.

Most container plants have a sample making machine which is a complete box plant in one unit. The machine includes a rotary two-bar slitter and scorer, with two pairs of slitting knives and two pairs of flap scorers mounted on steel shafts, a jaw slotter cuts out single slots, a bar creaser puts in body creases, and a hand shear takes care of trimming. Samples fabricated thus before a production run, aid the production and sales departments and guarantee the customer correct size, quality and style.

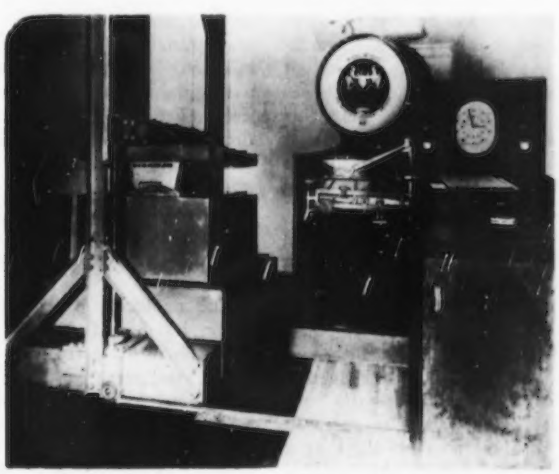


Fig. 11. Making top-to-bottom compression test.

Container Design

To design a container that will give maximum service requires the consideration of many things; appearance, weight, price, ease of handling and packing and protection to the contents. It is not always possible to allow a box to be proportioned to use the least amount of board for the maximum volume. A container designed as nearly as possible so that the length is twice the width and that the width and depth are equal, will use the minimum amount of board and realize the maximum strength. A container should have sufficient strength to protect its contents against the normal shocks and stresses it encounters in service and allow a margin of safety. The nature of the article to be packed, method of shipment, handling and warehousing are important considerations. An expensive piece of merchandise justifies a stronger, more durable container than an inexpensive one. Experience has shown that less protection is needed for shipments by truck and air than is required for rail shipments. L.C.L. shipments require more protection than do carload lot shipments. The problem of proper container design has for many years received the attention of research and industry. Some of the specifications that have been developed are applicable to a limited field, while others are of a general nature. For instance, those prepared by the Bureau of Explosives apply to the packing of male creasing wheels, etc., but variaothers like the American Society of Testing Materials and the Federal Specification Board are of a broad and basic nature. The Army, Navy and Air Force have set up their own packaging specifications.

Another factor in container design concerns manufacturing allowances. A container specified as so many inches long, so many inches wide and deep, in order to maintain uniformity, refers to inside dimensions. The different board combinations and flute heights must thus be taken into consideration. The allowances are not entirely uniform among plants because of the variations in fabrication methods, widths of male creasing wheels, etc., but variations in dimensions should not exceed 1/16″.

Testing

Container plants have their own testing equipment or employ the services of commercial testing laboratories. Container and materials testing is simply a device for predetermining the probable performance of containers and materials when they are put into actual use. Scientific machines and instruments have been developed that simulate conditions to which containers and their component materials are

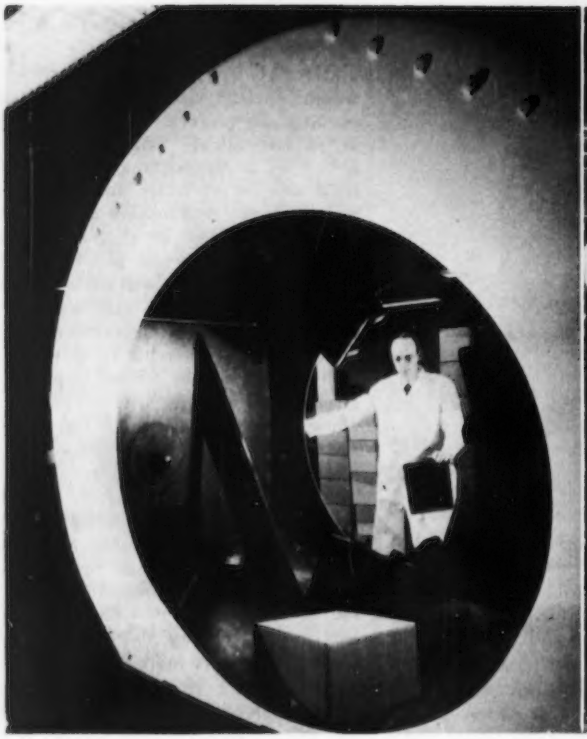


Fig. 12. Revolving drum test.

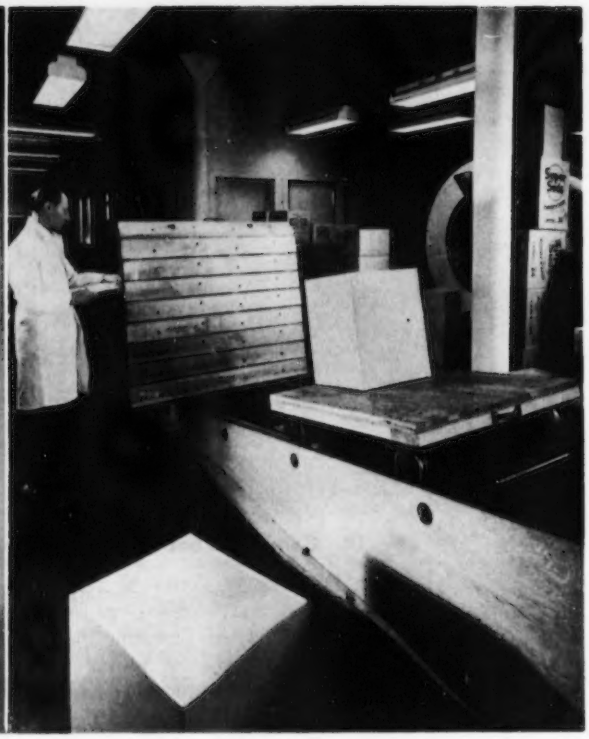


Fig. 13. Incline impact tester.

known to be subjected during their useful life. Regular testing procedures are the basis for a well rounded quality control program.

Paper and paperboard reflect changes in atmospheric conditions so for uniformity of results, the materials and finished containers are conditioned for a 24 hour period at 50 per cent relative humidity and 73°F. the standard set by the American Society for Testing Materials and by TAPPI. Other atmospheres are sometimes used to simulate conditions in which containers are stored or used. The most common tests of component materials are the basis weight, caliper determination, mullen or puncture test and Riehle test to measure stiffness or rigidity. Combined board tests are: mullen test, flat crush tests and tear tests.

Tests of containers themselves comprise: the compression test; revolving drum test; incline impact test; cushioning test; vibration test; drop test; score line tear test; scuffing test; and moistureproofness test.

To elaborate on a few of the more common tests on containers, we will discuss the compression test. This test subjects containers to compressive forces similar to those to which they may be subjected while enroute in freight cars and when stored in warehouses. Each container is tested individually both top to bottom and end to end in a large compression machine which consists of a platform scale over which a power driven crossbeam is mounted. The container to be tested is placed between two parallel surfaces; one the scale platform, the other a platen under the cross-beam. The applied pressure is read on an attached calibrated dial at each increase of 1/10" in the deflection or distance that the opposite surfaces of the container are forced together. One of the most common uses of compression tests is to measure the quality of fabrication of containers since the test specimens tend to fail at points of structural weakness. However, results of compression tests also can be applied, within broad limits, to determine safe stacking loads and warehousing periods of loaded containers. For most purposes the boxes are tested empty, but filled boxes, for example, may be tested to determine distortion of contents under piling loads or end compression as in freight cars. *(Figure 11)*

The revolving drum test subjects containers to treatment closely simulating handling during transportation. The machine used is a seven-foot hexagonal drum resembling a large barrel placed on its bilge. On the inside faces of the drum is arranged a series of baffles which cause the container to fall on its various parts in succession as the drum revolves at a constant speed of nearly two revolutions a minute. The number of falls which the loaded container can withstand before failure is a measure of its serviceability. The failures occur gradually so that weaknesses of design and construction can be detected readily. *(Figure 12)*

Incline impact tests simulate the stresses applied to merchandise in carriers such as freight cars or trucks, when the vehicles are subjected to sudden starts or stops. It consists essentially of releasing a loaded container mounted on a movable platform dolly which rides on a plane inclined 10 degrees from the horizontal and permitting it to strike against a fixed backstop at the bottom of the plane. The magnitude of impact shock is varied by using different release points. In packaging such items as gas ranges with enamel surfaces, the manufacturer finds it more economical to make some parts of the range heavier and stronger than necessary for efficient operation merely to reduce the packaging requirements and thus prevent damage to these parts in shipment. *(Figure 13)*.

The evolution of the container industry has been from wooden boxes to solid fibre to corrugated. The container industry has had an active growth as evidenced by these figures from the National Paperboard Association.

1942; square footage: 38 billion
1951; square footage: 74.5 billion

Fabrication of Solid Fibre Containers

Norman W. Garrison, Jr.

Eddy Paper Co.

Today we will discuss the fabrication of solid fibre containers. Although corrugated has supplanted fibre in many fields of packaging, the solid fibre box is still used extensively for packaging dynamite, explosives, paints, meats, cheese, boots, shoes, beverages, paper, and a list of other heavy articles.

Solid fibre has as its composition top and bottom plies of kraft or jute liners with inner plies of chip filler to build it up to the desired thickness. We have standardized on two thickness of chip, .028 and .038 caliper, to make up the various board combinations desired.

As an example for .060 solid fibre the combination would be:

Board Combination	*Caliper*	*Mullen-200#*
33# Kraft	.010	85
.038 Chip	.038	100
33# Kraft	.010	85
	.058	270

Plus adhesive.

Typical combinations for other calipers and grades are given in the following.

.080 Solid Fibre

Board Combination	*Caliper*	*Mullen-275#*
33# Kraft	.010	85
.028 Chip	.028	85
.028 Chip	.028	85
33# Kraft	.010	85
	.076	340

Plus adhesive.

Mr. Garrison's picture and biography appear with the other paper he presented at the lectures entitled the "Manufacture of Corrugated Shipping Containers."

.100 Solid Fibre

Board Combination	*Caliper*	*Mullen-350#*
33# Kraft	.010	85
.038 Chip	.038	100
.038 Chip	.038	100
33# Kraft	.010	85
	.096	370

Plus adhesive.

.120 Solid Fibre

Board Combination	*Caliper*	*Mullen-400#*
33# Kraft	.010	85
.028 Chip	.028	85
.038 Chip	.038	100
.028 Chip	.028	85
33# Kraft	.010	85
	.114	440

Plus adhesive.

Dynamite containers must comply with standards set up by the Bureau of Explosives.

Board Combination	*Caliper*	*Mullen-300#*
42# Kraft	.013	100
.028 Chip	.028	85
.028 Chip	.028	85
33# Kraft	.010	85
	.079	355

Plus adhesive.

The dry mullen test requirement is 300 lb., then after conditioning three days at 90 per cent relative humidity 75° F, it must withstand a mullen test of 200 lb. with a moisture content 30 per cent maximum. Specimens which are subjected to a 3 inch head of water for 3 hours must meet mullen requirement of 200 lb., at a moisture content of 30 per cent maximum.

In addition, containers loaded with blanks are subjected to compression tests and drop tests.

Weatherproof Solid Fibre Containers

The advent of weatherproof solid fibre has added stimulus to the solid fibre industry. This is a comparatively new development. There had been weatherproof containers on a small scale previous to 1940, but the war brought demands that greatly accelerated development.

Weatherproof board, or "V" board as it is commonly known, consists of liners and chip fillers that have had sizing or resins added during manufacture to produce resistance to moisture, then, when combined with a weatherproof adhesive, produce a board that will not delaminate, that is, come apart when immersed in water for long periods of time. The military authorities required containers that would withstand subzero temperatures, as well as tropical heat and humidity. Ration containers were often dumped from landing craft into the surf, then picked up when the tide went out. V board filled these requirements and is

continuing to do the job during the Korean conflict. Research and development of sizings, resins and adhesives is continuing; it is a subject in itself.

The two most common types of weatherproof adhesives are P.V.A., a polyvinyl alcohol base adhesive, and starch combined with urea-formaldehyde.

The board combinations necessary to meet "V" board requirements are as follows:

	Board Combination	*Caliper*	*Dry Mullen*	*Wet Mullen*
		.060	*175*	*50*
W6S	33# Kraft	.010	85	
	.038X Chip	.038	130	
	33# Kraft	.010	85	
		.058	300	
	Plus adhesive.			
		.075	*275*	*100*
W5S	33# Kraft	.010	85	
	.028X Chip	.028	105	
	.028X Chip	.028	105	
	33# Kraft	.010	85	
		.076	380	
	Plus adhesive.			
		.090	*400*	*150*
V3S	42# Kraft	.013	100	
	.028X Chip	.028	105	
	.038X Chip	.038	130	
	42# Kraft	.013	100	
		.092	435	
	Plus adhesive.			
		.090	*550*	*500*
V2S	33/52 Kraft	.025	200	
	0.20 Chip	.020	125	
	0.20 Chip	.020	125	
	52/33 Kraft	.025	200	
		.090	650	
	Plus adhesive.			
		.100	*750*	*500*
V1S	Usually inner and outer liners consist of kraft duplexed sheets with kraft inner plies.			

Production Equipment Used

The machine on which the solid fibre board is fabricated is called a paster. It is equipped to run as many as five plies. The board combinations are a kraft liner both top and bottom, and one, two or three plies of chip for center filler. The rolls are placed in roll stands, one roll being pulled from the top, the next from the bottom, causing the edges of the paper to push against each other preventing curling. Our machine has two adhesive stations. In making five ply board no adhesive is applied to the top liner; adhesive is applied to the top and bottom of the first ply of chip and to the bottom of the second and third plies of chip. The top and bottom liner is joined to the chip fillers just prior to the first set of squeeze rolls. There are five sets of squeeze rolls, each set has a higher degree of pressure applied consecutively in order that the starch is not squeezed out along the edges of the board. To keep a belly out of the board between each set of squeeze rolls, the rolls vary in diameter by five one thousands of an inch with the larger roll first, making each set of rolls pull just a little faster than the preceding rolls. The trimmed sheets come out of the cut-off on a conveyor adjustable for height and are piled in loads ready for the next operation.

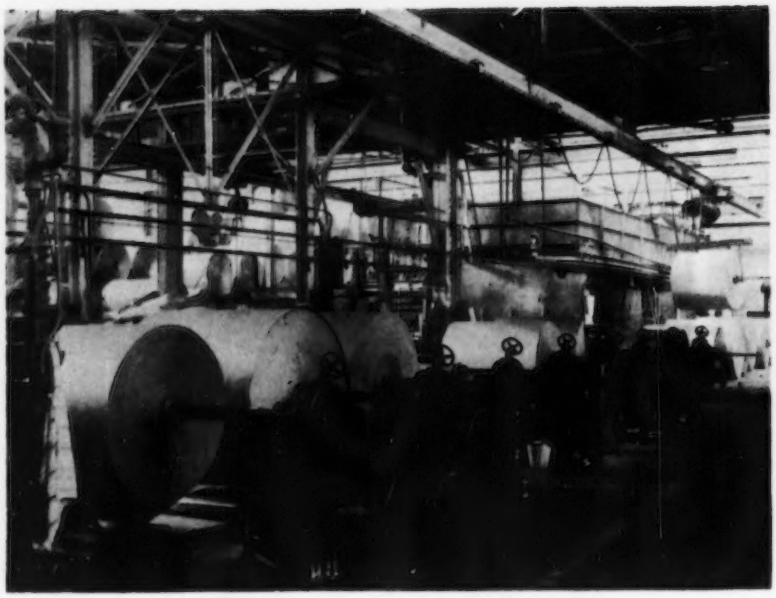


Fig. 1. Fibre paster roll stand section.

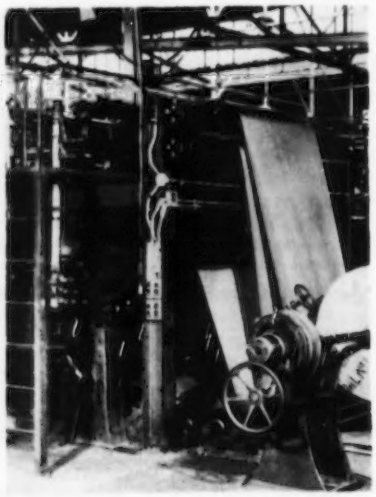


Fig. 2. Fibre paster double adhesive station.

Our paster has a maximum width of 86 inches, maximum speed of 315 ft. per minute.

The fibre presses perform three operations, creasing, slotting, printing. Some machines are hand fed, others have a slitting attachment in conjunction. The sheets are fed onto a conveyor that has spacer bars to guide the blank into the pull rolls of the first section of the press. Thus, the horizontal scores, the tapered slots and stitch flaps are accomplished. Pull rolls carry the sheet under the printing cylinders, which have either metal or rubber plates mostly called dies. Rubber plates or dies are previously mounted on a sheet of metal curved to fit the cylinder. Ink is worked down to the printing cylinders from the ink fountains in the same manner as on the corrugated presses through a series of rolls. A final form roll contacts the die; the die transfers the printed impression to the sheet. The printed sheet then passes through a third section, a chain creasing attachment that places the vertical scores.

The printing of solid fibre blanks that need not be creased or slotted is accomplished on a corrugated press. Die cut beer boxes are usually printed in this manner, since the setup time is less and the speed is greater on a corrugated press.

The closure or manufacturer's construction joint is usually stitched for fibre containers. The staples should not be more than three inches apart but when the depth of the container exceeds 18 inches the staples must not

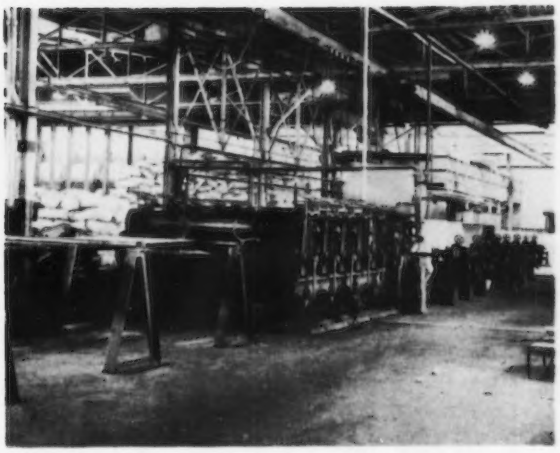


Fig. 3. Fibre paster squeeze rolls.

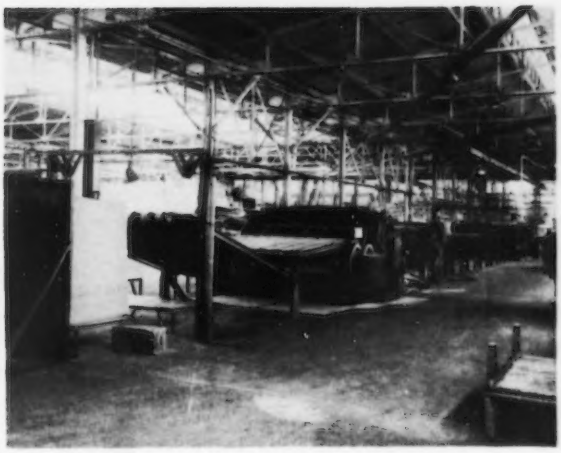


Fig. 4. Fibre paster sheet take-off.

be more than 2½ inches apart. When an extra strong joint is desired, it may be accomplished by means of an additional staple at the top and bottom of the joint. This is commonly known as a tie-stitched joint.

The glued manufacturer's joint is also being used on solid fibre containers. The hand operations, creasing, slitting, slotting, sawing, flap cutting, paraffine coating are accomplished in the same manner as the corrugated operations outlined in the preceding chapter.

Fibre is die cut in the same manner and on the same equipment as corrugated.

There are Seybold cutters or ream cutters that cut fibre sheets by a shearing operation. Sheets in piles up to 6 inches high are trimmed in one motion. Our machine as an example will handle sheets up to 84 inches in length and 84 inches in width, the minimum 3½ inches.

Solid fibre portions are formed and assembled on automatic equipment. The long way sheets are formed or punched out on a blanker from narrow width roll stock. Caliper varies from .040 to .050. The long way blanks are then fed by the operator into a machine that punches and cuts the short way blanks from roll stock and automatically assembles the partitions. The machines will cut blanks to produce cell sizes from 1-7/16 to 5 inches.

Weatherproof Corrugated Containers

Weatherproof corrugated containers are now being extensively used in the lower test brackets. Here again a sizing or resin is added to the liners and corrugating medium at the mill to produce resistance to moisture. A weatherproof adhesive is used in combining, to date the most successful has been the starch urea combination.

The board combinations to meet requirements are as follows:

	Board Combination	*Liner Caliper**	*Dry Mullen*	*Wet Mullen*
		.010	*175*	*50*
W6C	38# Kraft W.P.	.010*	90	
	33# Kraft W.P.	.010	90	
	38# Kraft W.P.	.010*	90	
			270	
		.016	*275*	*100*
W5C	69# Kraft W.P.	.016*	140	
	33# Kraft W.P.	.010	90	
W5C	69# Kraft W.P.	.016*	140	
			370	
		.023	*400*	*150*
V3C	90# Kraft W.P.	.023*	180	
	33# Kraft W.P.	.010	90	
V3C	90# Kraft W.P.	.023*	180	
			450	

Testing

The individual liners, chip fillers, and corrugating materials are subjected to an immersion test to measure the sizing properties of the sheet. The immersion test is expressed as the immersion number which is centigrams of water picked up by a 6 x 6 inch sample submerged in water at 73° F for 10 minutes. The paper is conditioned for 24 hours at 50 per cent R.H. 73° F previous to test. The individual 6 x 6 inch samples are then weighed to the nearest 0.01 gram, placed between wire screens and immersed horizontally to a depth of one inch in water. After 10 minutes the sample is removed, the excess water is blotted off by placing between two pulp testing blotters. The wet sample is immediately weighed to the nearest 0.01 gram. Immersion

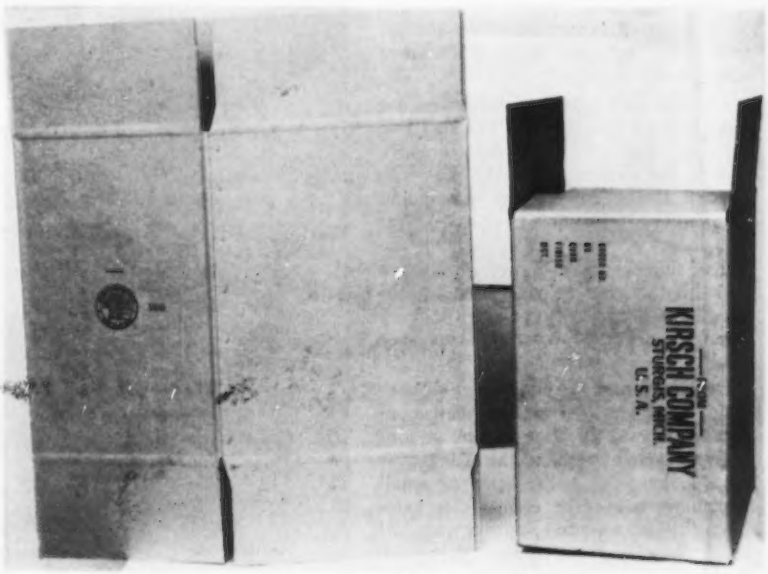


Fig. 5. Solid Fibre Sitched Container.

number then equals wet weight in grams minus air dry weight in grams times 100. Immersion numbers should run between 200 and 300 for lighter liners, slightly higher 400 to 500 for heavier liners.

To measure the weatherproof qualities of combined board other than a wet mullen test, a delamination or ply separation check is required.

Corrugated or solid fibre V board shall not have more than ¼" separation of plies at any edge after immersion in water for 24 hours when edges are flexed by pressure from the thumbs. The size of sample to be tested is 6 x 10 inches cut from unscored board. In the case of corrugated samples, the flutes are parallel to the six inch dimension. On solid fibre the grain direction is immaterial. The board is conditioned for 24 hours at 50 per cent R.H. 73° F. The samples to be tested are immersed in 73° F water vertically with the 10" direction horizontal and the surface of the water 1" above the top edge. The samples should not touch each other in the water. Ply separation evident prior to removal of specimens from the water constitutes failure. After 24 hours the samples are removed and shaken to remove excess water. Flexing of the specimen is done immediately. On corrugated only the 10" edges are tested, on solid fibre all edges are evaluated. The maximum ply separation is measured at right angles to that edge of the specimen from which separation began, i.e., a specimen could separate along 10 inches of one edge but as long as the depth of separation is ¼" or less the sample would still pass the specification.

The usage of solid fibre as compared to corrugated is dependent on the article to be packaged, mode of shipment and type of storage.

On the plus side for solid fibre we have greater resistance to puncture and scuffing, less effect or deterioration, due to the elements, and the most important factor from a cost standpoint, reusability. Returnable beer cases offer the most graphic example. On the minus side we have higher initial cost and shipping cost due to weight. Without inner packing very little stacking strength is gained from the container itself.

In many cases a combination of both solid fibre and corrugated makes an ideal package; as an example, a container designed to take the place of a wooden keg, for nails, bolts, or small hardware, has as its composition telescopic style top and bottom caps of solid fibre with an inner sleeve of double wall corrugated to provide stacking strength.

Fig. 6. Solid fibre die-cut beer box.

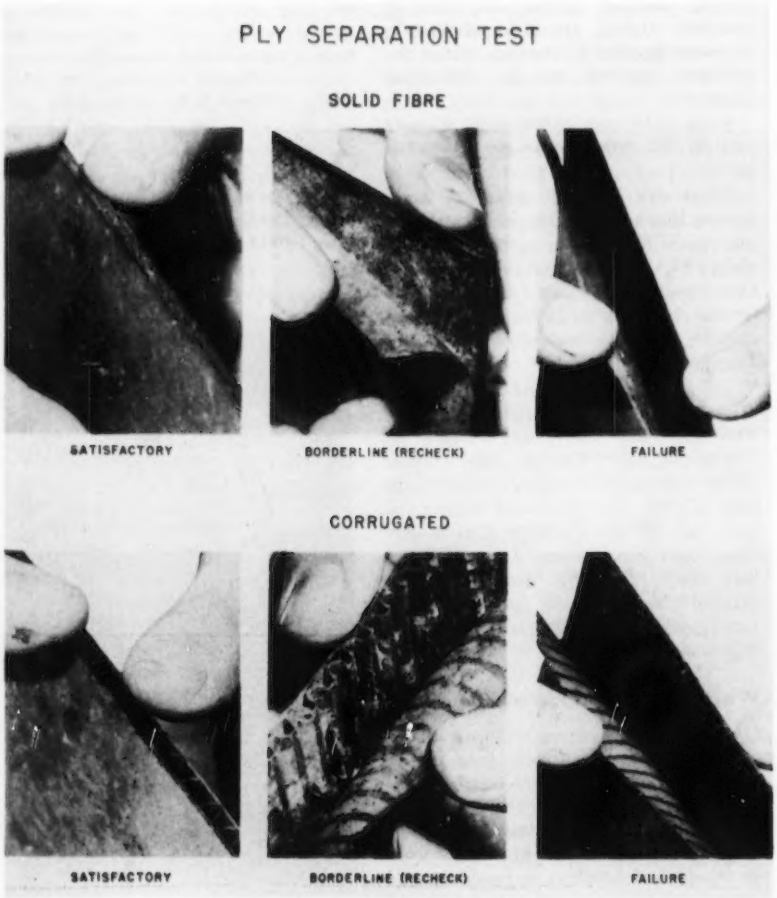


Fig. 7. Ply separation test.

Folding Cartons

William D. Hall

Folding Paper Box Ass'n.

It is my privilege to present for your consideration some challenging facts and information about folding cartons—the end product of a very large segment of our vast paper converting industries.

In order to distinguish folding cartons from set-up boxes and corrugated or solid fiber shipping containers and cases, the following definition is given:

"Folding cartons are packaging containers, either plain or printed, which are constructed out of bending grades of paperboard, cut and creased in a variety of sizes and shapes and delivered for use flat or in a glued and collapsed form."

Bending grades of paperboard, ranging from .012 to .052 inches in thickness and from 60 to 180 pounds per 1000 square feet in weight, are made from a variety of furnishes and possess many different protective characteristics.

In 1952 over 2,362,000 tons of paperboard was consumed in the manufacture of folding cartons. We may not readily comprehend the magnitude of this amount of paperboard; however, we can perhaps grasp the wide-spread acceptance of folding cartons as a packaging vehicle when we learn that each of us on the average used 620 that year. The average person does not see how he could have used that many until he is reminded of the many varied chores of product protection and merchandising which those cartons performed day in and day out.

But it was not always thus. We are all more or less aware, at least by hearsay, of conditions prevailing in those "good old days." Then products were delivered in bulk lots and it was the vendor's job to weigh out, cut or otherwise divide each lot into smaller sales units, usually while the purchaser waited.

Mr. Hall graduated from the Department of Printing Plant Management, Carnegie Institute of Technology and has taken additional courses at Northwestern University and Illinois Institue of Technology. His practical plant experiences began as a press-feeder in a carton plant and has included work in the various mechanical departments of graphic arts establishments. Production, sales and general management positions have been held with nationally recognized printing and lithographic concerns. Prior to joining the staff of the Folding Paper Box Assn. of America he had served as Director of Production-Management with the United Typothetae of America, now the Printing Industry of America, and Assistant Manager of the Washington Graphic Arts Assn. He has been active in the professional societies of the industry and holds a membership in TAPPI, TAGA, ASQC and the Chicago Club of Printing House Craftsmen.

Behind every folding carton is an exciting story of American "know how"—the mastery of materials and machines by human ingenuity, skill and experience.

Let us review a bit of the history and early development of folding cartons; learn something of the size and capacity of the industry which makes them; study their functions and characteristics; investigate the materials used and the manufacturing processes performed.

Historical Background

No one seems certain as to just when the construction and use of folding paperboard boxes began, but their forerunners can be traced back to a late period in the eighteenth century. Probably the first commercially produced folding paper box appeared in 1839 as the so-called "paper-of-tacks." These were crudely folded, quarter, half and pound packages formed around a mandrel, fastened with a tack and tied with string.

But the folding box idea did not really catch on until after 1879. In that year Robert Gair, who had already recognized the advantages of making a folding type of box, discovered by accident how cutting and creasing could be done on converted printing presses, thus pointing the way to their mass mechanical manufacture. He filed a patent application on April 10, 1879, but did not bother to pursue the routine necessary to secure the patent. An illustration is shown of the Aldine Press used by Robert Gair and also one of the latest platen models offered by the Thompson-National Co.

Seams of the early folding cartons were at first stitched, but soon glue began to be used on the flaps, and the boxes, after being folded by hand, were passed through a series of pressure rolls.

The first automatic gluing machine, built by a Mr. Cowles under a patent dated March 26, 1895, was quickly followed by the construction of similar equipment at the hands of such men as John Low, E. G. Staude and E. W. Labombarde. Although these machines are reported to have had the essentials of modern gluers—automatic feed, twisted belts for folding blanks, rapid screw adjustments for different sizes of cartons and conveyor delivery—continued improvements in their design, speed and versatility have kept gluing operations in step with other technological developments in the industry.

Originally, strawboard was used for stock and was laboriously lined by hand with a white or appropriately colored sheet of paper when the boxes were to be printed. In the beginning the printing was limited primarily to product name, directions for use and manufacturer's or distributor's identification. However, the lavish embellishments of the Nineties soon found their way onto the boxes of that time

through the use of wood engravings and the more elaborate and pictorial compositions made possible by the invention of photo-engraving.

Great impetus to the use of folding cartons resulted from the decision of the National Biscuit Company in 1896 to market its newly created "Uneeda Biscuit" soda crackers in a shell-type folding carton with a waxed paper inner-wrap and printed decorative overwrap. Promoted by an extensive advertising campaign, the package built such phenomenal sales for its sponsor that many other companies, particularly cereal manufacturers, quickly adopted the folding carton and the industry started on its climb upward.

Of course, the development of automatic filling and sealing equipment also helped make possible the rapid acceptance of folding cartons.

While no other specific reference regarding paraffin cartons is contemplated, this mention is made of the experiments in 1905, by E. H. Vavra of Cicero, Illinois, which resulted in the perfection and patenting of a process that became the basis of producing high-gloss "cold waxed" butter cartons and similar items.

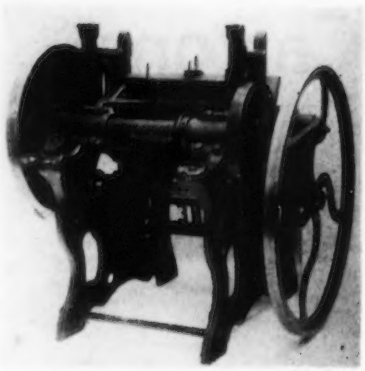
Size and Growth of the Folding Carton Industry

So much for the historical approach; now let us look at a few statistical facts and figures that will serve to indicate the importance of the folding carton industry.

At the turn of the century, only sixty-eight plants with approximately 2500 employees were engaged in the manufacture of folding cartons, or folding paper boxes as they were better known. These firms were sprinkled across the country and represented a capital investment of only five million dollars, which was relatively small even for the times.

By 1925, as the great packaging era was beginning to get into its stride, many new firms were being organized and additional plants built in order to meet the increasing demands for cartons. The records indicate an industry of 451 plants with capital investments amounting to eighty million dollars, and show that there were some 24,000 persons employed.

By 1950, as the second half of the century got under way, the industry had become a lusty growing member of the American industrial family with carton manufacturers in every important production center. Unlike many other great industries, the folding carton industry is not one of great concentration, as plants of all sizes are located throughout the country wherever they can best serve packaging needs.



(Gair Photo)

Figure 1. View of the Aldine Press converted by Robert Gair to manufacture folding cartons.

For the statistically minded, the industry numbered 560 plants with over 120 million dollars in capital investments. More than 45,000 trained men and women were used to convert annually more than two million tons of paperboard into folding cartons worth upwards of seven hundred million dollars.

Since all folding cartons must be die-cut and scored, this operation may be considered as the key to folding carton production. Cutting and creasing capacity provides an excellent measurement of the industry's potential capacity. It is expressed in terms of "million square inches per hour" (M.M.sq.in./hr). As an index, it is not subject to all the variables that exist in "shipment dollars" or paperboard tonnage statistics.

There are in general use two types of cutting and creasing presses—platens and cylinders. The sheets handled on a cutting and creasing cylinder are much larger than those cut on a platen press, and the cylinder also operates at higher speeds.

In the following tabulation, figures are shown for the two types of cutting and creasing equipment. There has been a gradual drop off in the number of platens and a substantial increase in the cylinder type with the net result that 1952 capacity will be 40 per cent over that of 1942.

FOLDING CARTON PLANTS AND CAPACITY OF THEIR CUTTING AND CREASING EQUIPMENT—1942-1948 THROUGH 1952

Year	Plants	Platens	Cylinders	M.M. sq.in./hr.
1942	516	1699	1271	6221
1948	569	1655	1615	7488
1949	552	1577	1621	7366
1950	560	1611	1677	7976
1951	558	1601	1723	8109
1952	569	1639	1852	8702

The expansion of the industry between 1942 and 1951 is shown in a comparison of the significant data tabuated below by number of plants, employees, capital invested, paperboard consumed and billings.

The 8 per cent increase in the number of plants is not in itself impressive. However, when one stops to realize that the production capacity of the 558 plants has been substantially expanded and the number of employees increased 48 per cent to handle a jump of 75 per cent in the consumption of paperboard, the continued rapid growth of the industry is striking. Also, note that the amount of capital invested increased 50 per cent. Billings during the same period, like those in many other industries, have zoomed skyward —reaching an amount 266 per cent over the 1942 figure, making a total of nearly 700 million in shipments.

Figure 2. Typical examples selected from the Gair Collection show styles of folding cartons in use around the turn of the century.

COMPARISON OF SIGNIFICANT DATA—1942-1951

	Plants	Employees	Capital	Paperboard Used (In Tons)	Billings
1942	516	30,600	$80,000,000	1,536,000	$189,900,000
1951	558	45,200	120,000,000	2,691,000	695,000,000
Increase	42	14,600	40,000,000	1,155,000	505,100,000
Per Cent	8	48	50	75	266

To indicate the wide range of goods being profitably packaged in folding cartons and the relative consumption of paperboard, an end use product classification breakdown has been prepared for 17 categories. The largest amount for any one category was the 20.1 per cent used for food products—not including candy, crackers or baked goods —and one of the smallest amounts was for the Army and Navy which amounted to only .5 per cent. No detailed comment is necessary regarding the other categories as the figures are self-evident.

END USE PRODUCT CLASSIFICATION—1952

	Tons, %
1. Army and Navy	.5
2. Medicinal Products	4.3
3. Cosmetics and Personal Accessories	4.
4. Soap	14.2
5. Food—Except Candy or Baked Goods	20.1
6. Candy or Confectionery	6.2
7. Crackers and Baked Goods	9.7
8. Tobaccos and Related Products	8.3
9. Hardware, Appliances and Automotive Supplies	5.5
10. Sporting Goods and Toys	1.3
11. Textiles and Apparel	3.2
12. Retail Boxes	6.2
13. Laundry Boxes	.6
14. Rubber Goods	1.1
15. Beverages	4.9
16. Paper Goods or Products	5.3
17. Miscellaneous	4.6
Total	100.0

There are numerous other interesting statistics which could be shown to indicate the growing importance of this industry but space does not permit their inclusion. So, the next area of investigation will pertain to the function and characteristics of folding cartons.

Functions and Characteristics

The evolution of the folding carton from a mere protective covering to an effective merchandising aid and sales stimulant has been continuous. Today, with the possibilities in mechanical and artistic design, color combinations, board variations and sales copy, the use of folding cartons for profitable packaging is virtually unlimited.

This is especially true in the current trend toward open display, self-service and impulse buying. Manufacturers and vendors of consumer goods are very appreciative of that extra measure of sales appeal which can be incorporated in folding cartons along with the other requirements of good packaging. Folding cartons are readily adaptable to manual operations for small production or use on the high-speed automatic filling equipment of larger producers. And, best of all, folding cartons perform their selling job simply, directly and economically.

If the folding cartons used in today's arena of competitive merchandising are to justify continued production, they must effectively fulfill these functions:

1. Serve as a container suitable in style, construction and material to make for ease in handling as the product is packaged, transported, and sold, as well as for convenience in use.

2. Provide protection for the contents against physical damage, breakage, mutilation, contamination and shringage because, regardless of cost, cartons are expected to deliver their contents in good condition.

3. Stimulate interest by serving as a point-of-purchase advertisement through which the superiority and advantages of the particular product can be paraded and brand identification insured.

4. Act as a salesman to impel buying, give adequate data and instructions for satisfactory and correct uses and thereafter continue to be a silent reminder to the consumer that the product is worth re-ordering.

Adaptability, versatility and economy are among the characteristics of folding cartons which make them ideal for packaging so many different products.

Adaptability includes such features as (1) conformance of the carton to the size and shape requirements of the items being packaged; (2) meeting production requirements of uniformity and close tolerances on large scale operations, which also may involve several suppliers; (3) providing visibility of product by the use of "windows" or over-wrapping filled trays with transparent film; (4) supplying brand identification together with a sales message without the extra operations and the expense of labeling; and (5) insuring convenience in filling, packing for shipment, store display and consumer use.

Versatility is shown by (1) the wide range of materials available; (2) the many styles and constructions from which to make a selection; (3) being able to incorporate cut-outs and sales boosters as part of the carton; (4) providing a choice of printing processes; (5) making possible the use of single or multi-colored designs, including those requiring highest pictorial reproduction; and (6) their suitability for small or large quantity production.

Economy is made possible through the proper selection of materials and printing process, and the benefits of quantity production in keeping with the requirements of the product. Savings in shipping, handling and warehouse costs result from the use of blanks or cartons in knocked-down form in comparison with other methods of packaging.

The embodiment of the functions and characteristics of folding cartons which have just been set forth in general and rather abstract terms can be seen in some outstanding examples of the designer's art and the carton manufacturer's skill.

Some of the prize winning cartons chosen from the hundreds of entries in the Eighth Annual Carton Competition, conducted by the Folding Paper Box Association of America, are illustrated in Figures 3 to 6. The cartons were judged on four classifications:

A. Technical superiority of printing, 3 divisions, best one-color, two-color and multi-color.

B. Technical superiority of construction, 2 divisions, ingenuity of construction, best display carton.

C. Best examples of potential new volume used for paperboard.

D. General superiority according to use, 15 product divisions.

Awards were given in each division for first and second place winners and honorable mention. Space does not permit showing pictures of all the award winners but those selected indicate a cross section of the styles and constructions which have been in common use for years or are adaptations of the basic principles of carton construction. Technical details concerning the various winners appear below each picture together with the name of the manufacturer of the carton. At the annual meeting of the Folding Paper Box Assn. the official representatives of the member companies examined all of the award winners and voted the "Blond Beauty" carton of Helena Rubenstein as the grand award winner for the year.

Nomenclature Charts

While literally there are hundreds of folding carton styles, the entire gamut evolved from the 2 preliminary concepts of the tube and tray which are explained as follows:

1. The tube—a sheet of paperboard folded over, then glued against its edges to form a rectangular tube, the ends of which can be sealed or locked in a variety of sizes.

L-R, Top to Bottom—
Figure 3. First Awards for Technical Superiority of Printing, Eighth Annual FPBAA Carton Competition. BEST ONE-COLOR: (A) Kenwood Blanket carton, a two-piece full telescope carton for F. C. Huyck & Sons made with rigid glued side walls and end walls, corners re-inforced with acetate fibre tape. BEST TWO-COLOR (Two Awards): (B) For Callaway Mills, Kwickset lid and Frame-Vue tray, with lid liner and (C) a reverse tuck for Clearsite Laboratories, Inc., knife slits in tuck keep carton locked and hold bottle. BEST MULTI-COLOR: (D) a lithographed six-color and varnished carton for Helena Rubenstein, Inc. This carton was selected as the GRAND AWARD WINNER.

Figure 4. First and Second Awards for Technical Superiority of Construction, Eighth Annual FPBAA Carton Competition. BEST DISPLAY CONTAINER, First Award: (A) display packer to hold rubber gloves on form flaps, made for Pioneer Rubber Co. Two Second Awards: (B) double-shelf display for Ball Pen Co., provides visibility and accessibility to product, display panel is self container, straight line glued, (C) Simpac boxes for Rockwell Tools, Inc., with racks and fillers to provide strength for shipping and point-of-purchase display. INGENUITY OF CONSTRUCTION, First Award: (D) patented package frames vacuum bottle for Landers, Frary and Clark, permits examination prior to purchase. Second Award: (E) Hewett P. Mulford and Company's bulb cartons with pinched-in top, features two Lumarith windows, insert tray holder keeps bulb in position at the upper window while a package of prepared soil wrapped in Pliofilm shows through the lower window.

Figure 5. Several of the First Awards in End Use Classifications, Eighth Annual FPBAA Carton Competition. SOAP: (A) carrier with inturn bottom holds ten bars of soap for Fels & Co. BAKERY GOODS: (B) glued open-end sleeve for Southern Biscuit Company to stimulate impulse buying. CARRIERS: (C) made of white carrier board printed in four colors for Birds Eye Division of General Foods Corporation. RETAIL BOXES: (D) a one-piece glued corner folder gives appearance of two-piece full telescope box for Saks Fifth Avenue Stores. HARDWARE: (E) bin box construction permits users of James R. Kearney Corporation's products to remove contents without disturbing other cartons stacked on shelves, corrugated re-inforcement. CONFECTIONS: (F) a two-piece full telescope carton, Sta-Up bottom and Kwick-Set top with acetate window, for Ludens, Inc.

Fig. 6. Additional First Awards in End Use Classification, Eighth Annual FPBAA Carton Competition. TEXTILES: (A) Kwick-Set cover on carton for Chatham Electric Company. TOBACCO: (B) Packer display and individual cigarette cartons of unique slide and sleeve construction. COSMETICS: (C) Straight tuck with extended overlapping panels featuring tongue and slot closure and dial-a-day device with protective features embodied in platform and strap retaining units, stock for Warner-Hudnut Co. TOYS: (D) Gabled top carton with handle and Quickloc bottom for Sayco Doll Corp. PAPER GOODS: (E) Full seal end with special fold back dispensing orifice for Rhinelander Paper Company. FOODS: (F) Wall-type dispensing unit for Leslie Salt Co., carton for miniature salt shakers designed for self-service outlets.

2. The tray—a sheet of board with its sides folded at right angles and locked or stitched together at the corners. One panel can be extended to form a cover or 2 trays can be fitted together to form the top and bottom of a complete box.

To help clarify the very confusing situation resulting from a flood of construction ideas, the Folding Paper Box Association was instrumental in securing an adoption of standard terminology and prepared a series of Nomenclature Charts showing 18 styles. These include:

Chart I—Reverse Tuck Carton.
Chart IIa—Straight Tuck Carton.
Chart IIb—Straight Tuck Carton.
Chart III—Full Seal End Carton.
Chart IV—Lock End Carton.
Chart V—Tuck and Seal End Carton.
Chart VI—Two Piece Telescope Friction End Box.
Chart VII—Mailing Tuck End Carton with Arthur Side Locks.
Chart VIII—Lock Top—Seal Bottom Carton.
Chart IX—Telescope—Lock Corner Carton.
Chart X—Cracker Shell Style Carton.
Chart XI—Single Lock Cake Box Style Carton.
Chart XII—Two Piece Telescope Brightwood Style Carton.
Chart XIII—Telescope — Hardware Lock End Carton.
Chart XIV—Tuck Top—Lock Bottom Carton.
Chart XV—Straight Tuck End Carton with Full Overlapping Flaps and Side Tucks.
Chart XVI—Four Corner Lock Bottom Carton with Hinged Cover.
Chart XVII—One Piece Brightwood Blank with Hinged Cover.

Small drawings are reproduced (in figs. 8, 9, 10 and 11) of the several styles for which nomenclature charts have been prepared.

The one for a reverse tuck carton has been enlarged and is reproduced with an added diagram for "printing bleeds" and score marks to be inserted in the art work.

Stock Boxes

For years it has been the practice for some carton manufacturers to produce a line of cartons principally for retail establishments whose purchases do not justify the buying specially designed printed cartons. A wide variety of stock boxes are provided for bakers, tailors, dry cleaners, laundries, milliners, department and specialty stores. The cartons are produced in standard or stock size in large volume and sold either imprinted or blank in small quantities to the user.

Materials Used

Any discussion about the production of folding cartons might logically begin with a review of information about the principal material used—folding boxboard. No detailed explanation about the operations performed in making pulp and paperboard will be given as there is a great deal of published literature readily available. However, to be certain that there is common understanding about the boxboard used for folding cartons it may not be amiss to comment on the kinds and characteristics of the more generally used grades.

Boxboard

First, note that the term "paperboard" commonly referred to by many as simply "board" or "fiberboard" is used to describe all grades of fibrous materials made on a paperboard machine. These are designated in terms of the industries for which they are being produced. Hence, the name "folding boxboard" is applied to those bending grades made for the express purpose of being fashioned into folding cartons. They are usually made on cylinder board machines and are expected to score, bend or fold without cracking or breaking.

The chief qualities looked for in these grades are:

1. Strength, to protect adequately the products packaged.
2. Flexibility, to permit bending up to 180° without cracking or breaking where creased.
3. Appearance, to enhance the "eye appeal" of the package.
4. Printability, to possess a suitable surface for printing.
5. Stiffness, to have rigidity to hold required shape and to function satisfactorily on automatic filling machines.
6. Resistance to penetration or absorption of moisture, grease or gases.

The cross section of folding boxboard reveals three distinct sections: (1) the top liner which becomes the outside surface of the carton; (2) the bottom liner which forms the inside of the carton and comes into contact with the product; and (3) the filler or center section which gives the required bulk to the stock and is usually several times the thickness of either liner.

In most cases the same quality of pulp is not used for all three sections as to do so would add materially to the cost of the stock without a proportionate advantage.

Raw Materials

The raw materials used in making folding boxboard consists of reclaimed paperstock, chemical and mechanical pulp and various chemicals. The principal ingredient is waste paperstock of which the important sources are: mixed papers, baled news, used corrugated containers, boxshop clippings, old kraft paper, manila paper, envelope clippings, white book paper shavings, and white envelope clippings.

Wood pulps are next in importance and provide added strength, bending quality, finer finish, color, and some other desired characteristics. They are of two kinds, mechanical or ground wood pulp, either unbleached or bleached; and chemical pulps identified as unbleached kraft, unbleached sulphite, bleached sulphite, and soda pulp.

Among the chemicals used are rosin and caustic soda for size, alum for setting it and to neutralize alkaline conditions, clay for coating, casein used with clay in coating, titanium pigment for opaqueness, starch for finish, and color pigments and dyes.

By varying the raw materials and coloring matter in liners and fillers and applying various surface coatings, an almost endless variety of folding boxboard could be produced. As a practical proposition the strength and length of the fiber, color, and other physical requirements definitely limit the choice on one hand; and availability, reasonable cost, transportation and storage limit it on the other.

Another way to produce folding carton stock is by laminating or combining paper of special characteristics with boxboard by gluing them together while in roll form.

Grades of Folding Boxboard

The bulk of the boxboard most commonly used for folding cartons comes within the first five classifications or grades described below.

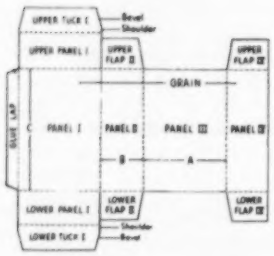
Bending Chipboard: This is the lowest grade of folding boxboard being made principally of reclaimed papers with enough new sulphite pulp added to give it the necessary bending qualities required. It is dark gray in color and unsuitable for multicolor printing.

Single Manila-Lined Board: A commercial grade of boxboard having a top liner of unbleached sulphite and groundwood pulp with the balance of the board composed of news or mixed papers. The top liner is distinguished by its manila color.

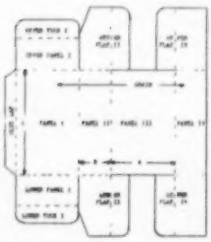
Bleached Manila-Lined Board: A slightly higher grade of folding boxboard produced from the same basic ingredients but it is whiter in color than the single manila-lined board. It is extensively used for folding cartons of all kinds and sizes.

White Patent-Coated Board: It is made with a top liner of bleached chemical wood pulp mixed with white shavings, aspen or soda pulp to pro-

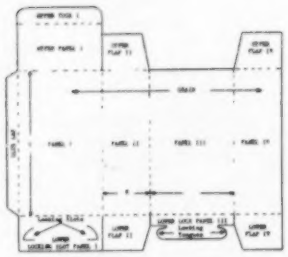
STRAIGHT TUCK CARTON



STRAIGHT TUCK END CARTON
WITH FULL OVERLAPPING FLAPS AND SIDE TUCKS



TUCK TOP - LOCK BOTTOM CARTON



ONE PIECE BRIGHTWOOD BLANK WITH HINGED COVER

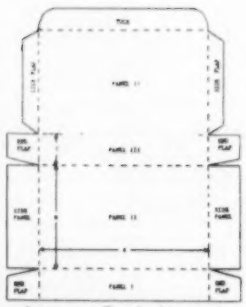
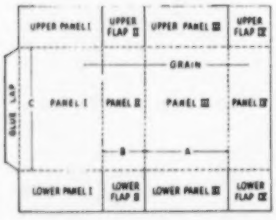
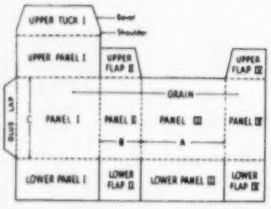


Figure 7—Four of the Nomenclature Charts of folding carton styles prepared by the FPBAA. The diagram of the blank shows the outline of the carton facing up, with the glue flap to the left. Printing on the carton is purposely disregarded in designating nomenclature. Dash lines denote creasing, solid lines show cuts. The larger panel dimensions of the carton with the grain is designated (A), the smaller (B) and the third dimension is (C).

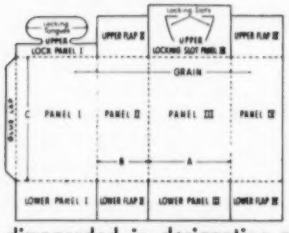
FULL SEAL END CARTON



TUCK AND SEAL END CARTON



LOCK TOP - SEAL BOTTOM CARTON



LOCK END CARTON

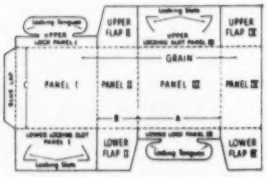
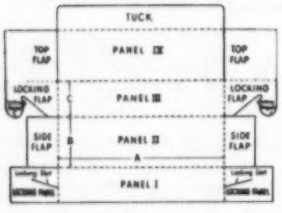
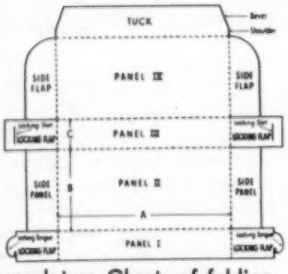


Figure 8—Four additional Nomenclature Charts of folding carton styles prepared by the FPBAA. The diagram of the blank shows the outline of the carton facing up, with the glue flap to the left. Printing on the carton is purposely disregarded in designating nomenclature. Dash lines denote creasing, solid lines show cuts. The larger panel dimension of the carton with the grain is designated (A), the smaller (B) and the third dimension is (C).

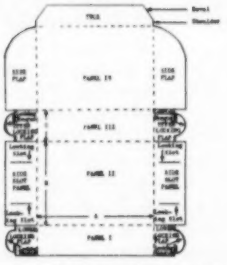
CRACKER SHELL STYLE CARTON



SINGLE LOCK CAKE BOX STYLE CARTON



FOUR CORNER LOCK BOTTOM CARTON
WITH HINGED COVER



MAILING TUCK END CARTON
WITH ARTHUR SIDE LOCKS

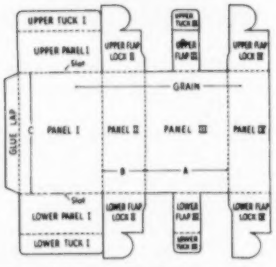
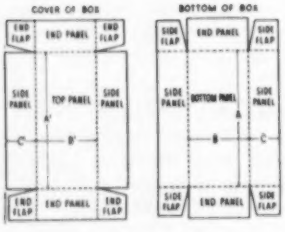
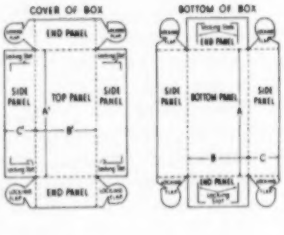


Figure 9—Four additional Nomenclature Charts of folding carton styles prepared by the FPBAA. The diagram of the blank shows the outline of the carton facing up, with the glue flap to the left. Printing on the carton is purposely disregarded in designating nomenclature. Dash lines denote creasing, solid lines show cuts. The larger panel dimension of the carton with the grain is designated (A), and smaller (B) and the third dimension is (C).

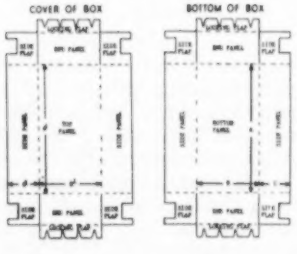
TWO-PIECE TELESCOPE BRIGHTWOOD STYLE



TELESCOPE - LOCK CORNER CARTON



TELESCOPE - HARDWARE LOCK END CARTON



TELESCOPE FRICTION END CARTON

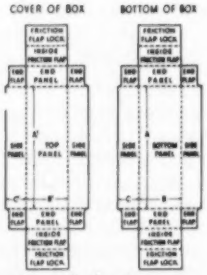


Figure 10—Four Nomenclature Charts of two-piece telescope style cartons prepared by the FPBAA. The diagram of the blank shows the outside of the carton facing up. The printing on the carton is purposely disregarded in designating the nomenclature. Dash lines denote creasing, solid lines show cuts. The larger dimension of the bottom panel of the box is (A), of the cover is (A'), the smaller dimension of the bottom panel is (B), of the cover is (B'). The depth of the bottom of the box is (C). The depth of the cover is (C').

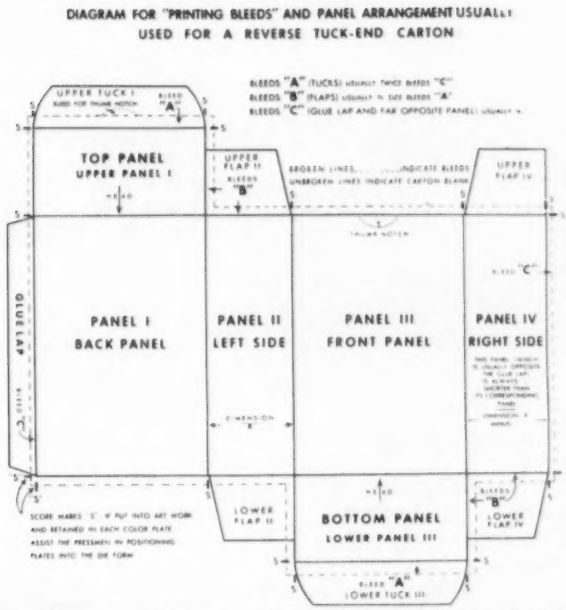


DIAGRAM FOR "PRINTING BLEEDS" AND PANEL ARRANGEMENT USUALLY USED FOR A REVERSE TUCK-END CARTON
BLEEDS "A" (TUCKS) USUALLY THICK BLEEDS "C"
BLEEDS "B" (FLAPS) USUALLY ½ SIZE BLEEDS "A"
BLEEDS "C" (GLUE LAP AND FAR OPPOSITE PANEL) USUALLY ¼
UPPER TUCK I
BLEED FOR THUMB NOTCH
BLEED "A"
TOP PANEL
UPPER PANEL I
UPPER FLAP II
BLEEDS "B"
BROKEN LINES ..... INDICATE BLEEDS
UNBROKEN LINES INDICATE CARTON BLANK
UPPER FLAP IV
THUMB NOTCH
BLEED "C"
GLUE LAP
PANEL I
BACK PANEL
PANEL II
LEFT SIDE
PANEL III
FRONT PANEL
PANEL IV
RIGHT SIDE
DIMENSION X
SCORE MARKS S S PUT INTO ART WORK AND RETAINED IN EACH COLOR PLATE ASSIST THE PRESSMEN IN POSITIONING PLATES INTO THE DIE FORM
LOWER FLAP II
BOTTOM PANEL
LOWER PANEL III
BLEEDS "B"
LOWER FLAP IV
BLEED "A"
LOWER TUCK III

Figure 11—A diagram of the reverse tuck end carton showing "printing bleeds" and score marks together with panel arrangements. This is an adaptation of one of the Nomenclature Charts prepared by the FPBAA.

duce a good, white surface suitable for multicolor printing and is one of the most desirable of all folding boxboards for high grade carton manufacture. The name is a misnomer as it is neither a patented nor a coated board.

Clay-Coated Board: A single manila-lined sheet on the top liner of which a coating of white clay, or other mineral substance, mixed with water plus starch or similar binder, is applied to produce a white printing surface. This is hard, smooth and clear and will take most types of printing or varnish well. The coating can be done either on the paper machine or after the usual machine operations are completed.

Solid Board: Produced entirely from a virgin pulp of either kraft or sulphite, or a mixture of either with ground wood and called *Solid Manila.* It is used extensively for packaging moist foods, especially those subject to contamination.

Many products that are now being packaged in folding cartons require the use of boxboard which must be given special treatment in order to provide a satisfactory container. In addition to laminating, three other common treatments are silicating, asphalting and lining or coating with grease-resistant material.

Most of the folding boxboard stock is sold in sheet form cut to the desired size and assembled in bundles of a standard weight of fifty pounds each. Better grades of stock in sheet form are being piled on skids for handling and shipment while many converters are having boxboard supplied in roll form for use on web printing equipment.

Terms and Definitions

Among the terms and definitions pertaining to folding boxboard that should be known are:

Bundle: A bundle of folding boxboard weighs fifty pounds and is standard regardless of the caliper, size or basic weight of the sheet. The number of standard 25 x 40 size sheets in a bundle is the "regular" number while the number of sheets of any other size is the "count."

Finish: The degree of board smoothness is determined by the pressure of the calender rolls and expressed numerically from 1 to 4 for the four finishes. Number 4 has an extra smooth surface; Number 1 is least smooth. Number 2 finish is popular for ordinary printing.

Furnish: The term used to designate the combination of raw materials used to produce the many different grades of board.

Sheet Dimensions: The dimensions of a sheet are always stated with the first dimension being the direction *across* the grain and the second being the dimension *with* the grain.

Standard Sheet Size: 25 x 40 inches in size with an area of 1,000 square inches. While folding boxboard is bought in sizes to meet individual job requirements the basis for estimating weight on all grades and other computations is this standard sheet size.

Sheet Thickness: Sheet thickness or caliper is expressed in 1000th of an inch, each 1000th being referred to as a "point."

Production of Folding Boxes

Having taken a look at the materials from which folding cartons are fashioned, attention is now directed to the creation of a special order carton and the manufacturing processes involved in its production. There are three major phases through which a carton progresses from its conception until it is ready for use. These are the preliminary or planning stage, the preparatory work and the actual mechanical production.

Preliminary Stage

As all carton manufacturers are desirous of delivering a product which is best suited to the requirements of the user, the first or preliminary stage is very important. Accurate and detailed specifications must be established and the designer responsible should, by analysis and investigation, become entirely familiar with the product, or item; select or adapt a suitable construction style; and then work out merchandising ideas and design.

A brief list of points to check in connection with the product includes:

a. What is the product?
b. Of what, and how is it made?
c. What is its purpose?
d. What kind of container is required?
e. What amount of product protection is needed?
f. Who will buy it, when, in what units, and where?
g. Who will use or consume the product?
h. How much is known about the product?
i. What sales resistance exists against acceptance?
j. What direct or indirect competition must be met and overcome?

The second step in the preliminary stage is the selection of the style of carton best suited to meet the conditions brought out in the first step, keeping in mind that the materials for the package must be readily obtainable, economical, practical and provide the required protection. Also, how the package is to be filled—by hand or automatic machine, and how it will be packaged in cases for handling, shipment, storage, and display in the outlets indicated. The style should be such as to make its use convenient, suitable for reclosing and later use, if necessary, and at the same time pre-

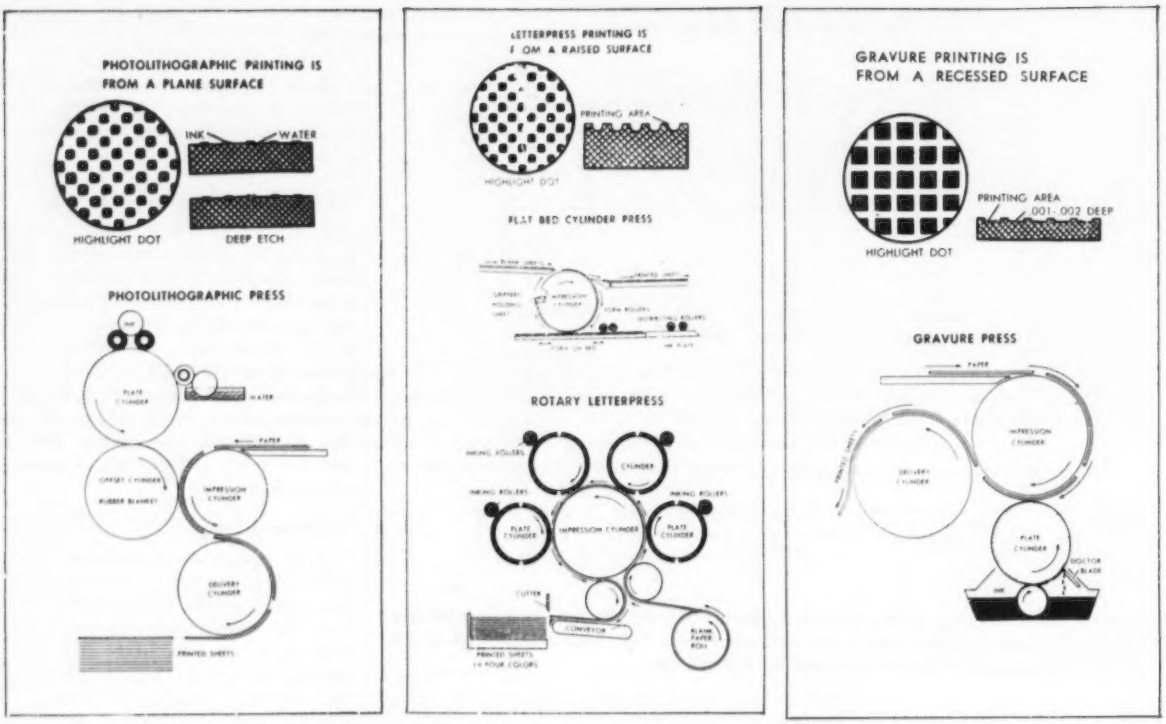


Figure 12—Printing processes used in the converting industry.

vent deterioration of the unused portion.

Simultaneously with the selection of a suitable style, merchandising factors must be weighed and a satisfactory design created.

These involve:

Brand identification; inclusion of trade mark or "family line" pattern; the product advantages to be stressed in illustration and copy; information and directions for use that must appear; any illustrations to demonstrate and prove usefulness and desirability of product; knowledge of the design features of the competitive product; and what color or colors should be used to give the package attention value and pictorial realism to the product.

Based upon the findings and determinations made in the preliminary steps just discussed, design sketches and hand-cut samples are prepared for submission to and approval by the customer. Also the detailed specifications should be agreed upon, if the original ones proposed by the buyer are not complete or fully adequate. A production layout is then made showing, along with other construction details, the number of carton blanks to be cut from a specified size sheet of boxboard —one which "trims" well for the boardmill and which can be handled on the equipment in the carton plant. Manufacturing costs are projected in price estimates together with figures evaluating the cost of any alternative provisions in the specifications.

Thus, the preliminary phase may be considered to end with the making of a production layout and the submission of a proposal with specific prices.

Printing Processes Used In Converting Industry

Any such proposal implies that the method of printing the cartons has been considered and selected in conformity with the requirements of the job as well as the availability of equipment. This reference to the method of printing is made because any of the four graphic art's reproduction processes or printing (letterpress, offset lithography, gravure and stencil) can be utilized in the production of folding cartons.

However, since each process requires its own specially designed presses and skilled craftsmen, most concerns are equipped to do only one kind of printing. In those plants where more than one process is available, the additional methods usually have been brought in to do work requiring unusual treatment or to handle specific types of jobs which can be most economically produced at high speeds by that method.

The great bulk of folding cartons are printed by the letterpress method on a wide variety of sheet and web-fed equipment with simple or multiple-color printing units. The flexographic process, formerly known as aniline printing, is a letterpress method, utilizing rotary equipment, rubber plates, and a fluid type of ink.

Offset lithography, used mostly for high quality multicolored work requiring a high degree of pictorial excellence is being produced by a number of firms but still only a comparatively small proportion of cartons manufacture are produced by it. Gravure, especially the web-fed units in two to five colors, is being increasingly used on long run items such as soap cartons and is frequently tied in with die-cutting and stripping equipment. Sheet-fed gravure presses are being operated by one concern in the production of some process-color work. The screen process printing of folding cartons is being tried by a few people on short runs and test items but it is not at present an important factor. In the following section and in the actual mechanical production discussion the operations described pertain to letterpress printing, although some general statements relating to the other processes will be included.

Preparatory Work

Upon approval of sketch and sample, agreement on specifications, and ac-

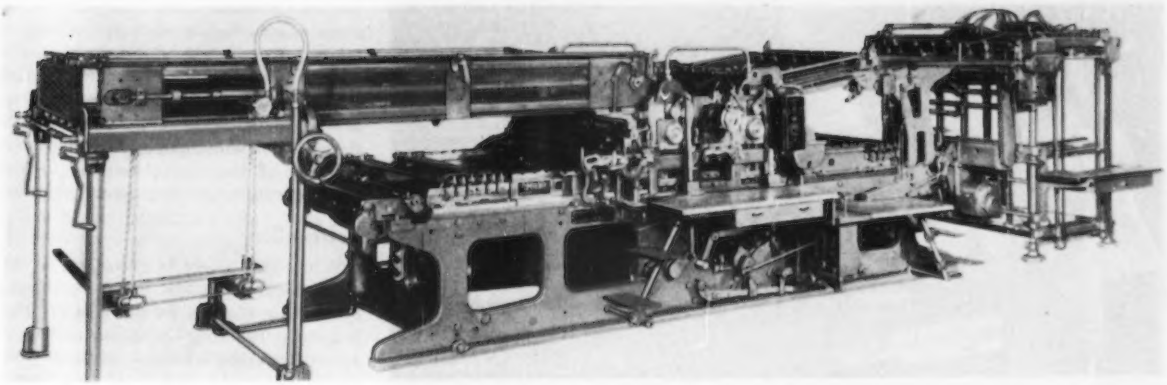


Figure 13—A Miehle Two-Color Letterpress

ceptance of quotation, the preparatory work begins in earnest. Both the procurement of the required materials and the performance of those operations in preparation for the production runs are covered at some length under their respective headings.

Art Work

The initial step is either the preparation of finished art work, by the plant's staff artists of its purchase from an outside studio. This should cover complete working drawings along with prints of any pictures that are needed and text mater set in type for insertion or assembly with the various elements of the design. Full scale drawings of exact dimensions with provision for scores and folds, register marks and color separation details clearly indicated on tissue overlays all help insure satisfactory printing plates. The art work may be only simple lettering combined with type or it may consist of process-color subjects projected over elaborate background designs.

Boxboard

While the art work is being completed and the buyer's approval sought, negotiations for boxboard of the required specifications can proceed so that stock for printing will be on hand when needed. This might mean requisitioning from a firm's own mill or purchase from other sources capable of supplying the specific kind wanted.

Engravings

Engravings are next and can be ordered upon receiving approval of the art work. They may be made by one or more photoengraving techniques by which the design image for the outside of the carton is transferred in negative form by the photographic process to a metal plate.

There are three basic kinds of engravings:—line and solid areas without shading, usually on zinc, are known as line engravings; those with shaded areas obtained by mechanical devices are Ben Day plates; while the third kind, or halftones, are made by photographing on copper a painting, photo or other copy through a very fine screen, thereby permitting the reproductions of details and shadings with a high degree of accuracy.

For work to be printed in more than one color, separate engravings are required for each color. Also, they must register so that when printed the colors will appear in proper relation to each other. Engravings should never be used for actual printing purposes but should serve as master copies from which the required duplicates can be made.

Ink

Since the colors in which a carton design is to appear are of the utmost importance to the customer, the printing ink supplier is brought into the picture as soon as possible. He is instructed to formulate inks which will match the authorized color specimens, or designated color standards. It is wise to provide the engraver with samples of the inks and actual board samples if at all possible so that his engraving proofs will show how the final results will appear. Some companies prefer

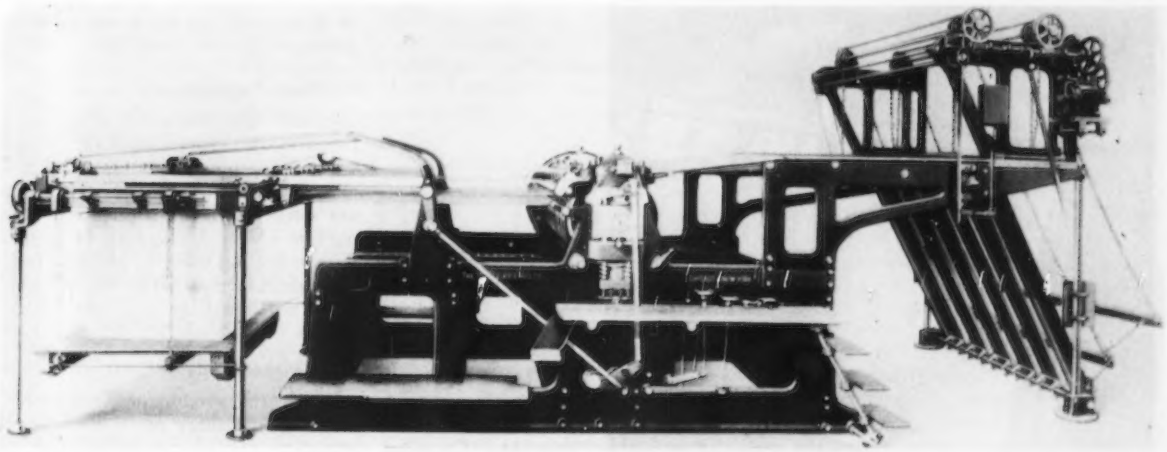


Figure 14—Miehle Cutting and Creasing Press with Berry Lift.

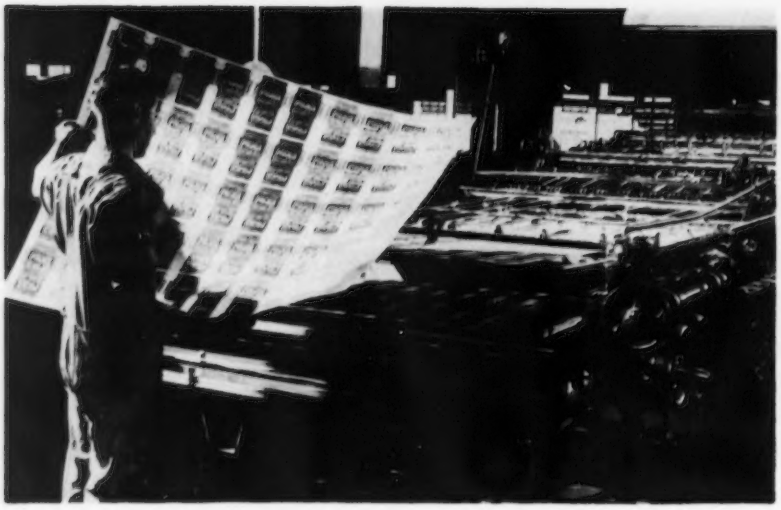


Figure 15—Delivery end of Letterpress

to wait until the actual printing plates are available before proofing on the stock with actual ink smaples.

Electrotypes

As indicated before, engraving should be used as master plates from which the desired number of duplicates can be made. This is done by an electroplating process by which copper is deposited over a wax or lead impression made from the original. These may also be nickel, chrome or even steel plated. Electrotypes are much less expensive than the originals and usually wear longer. Plates damaged in printing can be quickly replaced by another electrotype made from the master. Plastic and rubber plates have been tried but it is felt that extensive development work is necessary before they can gain popular acceptance in this industry. When the electrotypes are received from the foundry each should be thoroughly examined and proofs should be pulled on a Vandercook or similar precision proof press. Bad plates can be detected and rejected or corrected depending upon the fault. The electrotypes are beveled along their edges for mounting on a patent base. Held in metal hooks or catches, the plates can be moved into proper position and register while some plants nail or tack the plates directly on end grain wood base material. The laying of the electrotypes on the patent or wood base in proper arrangement to fit and coincide with elements of the cutting die constitutes another of the operations performed in preparation for the actual printing.

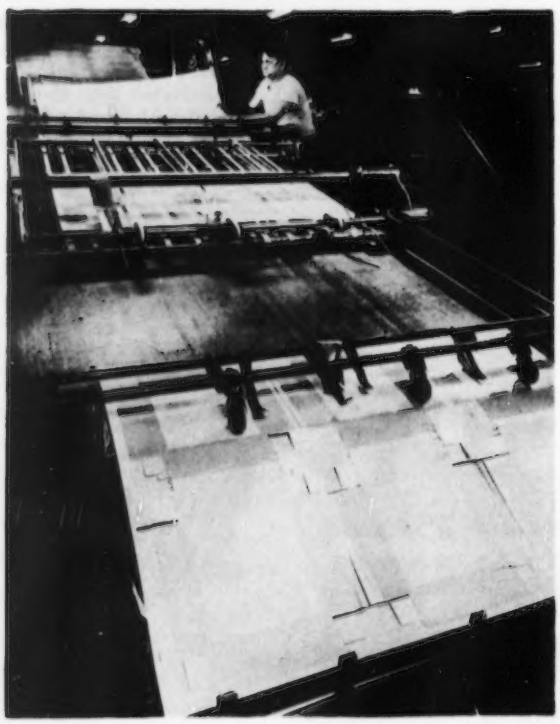


Fig. 16—Delivery of cut and creased sheets from a Cutting and Creasing Press.

Cutting Die

While the above is going on, a cutting and creasing die can be produced by the die makers in the plant. This is a very exacting operation and work must be painstakingly accurate because the serviceability of this carton depends upon the uniformity of the multiples units in the die form.

The die is made from carefully shaped pieces of steel cutting, creasing and/or perforating rule designed to cut out, crease and perforate the individual carton blanks from the large sheets of boxboard which will have been printed previously. The rules, carefully fashioned to the pattern of the approved hand-cut samples and layout sheets, are held in place by means of accurately cut pieces of plywood or metal approximately ¾-inch thick. The assembled die is locked or wedged in a steel case which holds it together ready for use on the cutting and creasing press when needed.

After a die form is finished a hand sample is made from it for checking purposes and approved for production. Then a die sheet is prepared from a carbon paper impression of the rules in the die form on a manila sheet or book paper which can then be oiled for transparency. This die sheet is the guide from which printing plates are positioned.

However, before a die can be used small pieces or cork, rubber or other resilient material are attached along the edges of the cutting rule to push the boxboard away from the knives as soon as the cutting operation is performed.

Pre-Press Preparation

Under this designation a number of preparatory operations can be performed depending upon shop practices and the extent to which material items are subjected to pre-testing and examination. As each category of material is received it should be checked and if not in conformity with the speciafications it should be rejected or corrected.

Press Make-Ready

The first production operation is printing and there are numerous preparatory steps that must be taken befor the presses are ready to run. These

include the preparation of the press for printing by properly packing the cylinder and setting the sheet feed and delivery mechanisms. The printing plates are then locked on the bed of the press and properly lined up with the die sheet. When work of more than one-color is being printed, the plates of the separate colors must be brought into register with a key form. The ink fountain and printing rollers must be adjusted so that an even coverage of ink is secured. Unevenness in the printing form is corrected by make-ready to compensate for the high and low areas and the irregularities in the printing press bed and the impression cylinder. Adjustment of offset spray equipment or other attachments to eliminate offset and smearing are among the last preparatory operations and may even be done after the run is started. When the position has been secured, make-ready completed and fountain set, a press okay is obtained before the run actually starts.

When two-color presses are used, two separate printing forms are run simultaneously on separate printing cylinders, the two forms being in proper register before the run starts. Multi-color work involving more colors than can be printed at one time necessitates feeding the paper through the press for the additional colors. To faciltate the registering of forms with their key sheet and with the die sheet, mechanical aids, such as the Taylor Register Scope, are utilized in a number of plants.

Detailed descriptions of the various make-ready and register operations are not attempted as they would tend to become quite technical and involved.

Cutting And Creasing

After the printing operations have been completed the paperboard sheets are fed through a cutting and creasing press similar to the printing machines except that there is no inking system on the press and the die form previously described takes the place of the printing plates. Make-ready is required to prepare the cutting die to run. To cut and crease with accuracy and precision, the surface against which the paperboard rests at the time of impression must be grooved to fit the knives of the die. For this purpose a counter is prepared by gluing a sheet of board to the steel jacket which covers the cylinder, or to the platen, depending upon the type of press.

After an impression has been taken on this sheet, portions of it are cut away so that the cutting rule will come in direct contact with the steel jacket. The creasing rule is made ready by cutting a groove in the counter of the proper width, depending on the thickness of the paperboard and the width of the crease. The crease or score is made when the sheets are run between the die form and the counter.

Actual Mechanical Production

The third phase in the manufacturing of cartons is the actual operation of the machines and equipment as they convert the boxboard, ink and adhesives into a desired end product.

The first is printing, which is done by the letterpress process, also known as relief or typographic printing. In this process the image to be printed is higher than the surface of the surrounding areas of the form or plate. The actual printing is accomplished, much in the same way as a rubber stamp is used, by applying ink to the raised portion of the design and transferring it by mechanical means to the sheet of paper or other material being printed.

Letterpress Presses

Letterpress printing is done on a wide variety of presses classified by their construction and operating principles as platen, flat-bed cylinder and rotary.

Platen presses as used today are a modern version of the style of press which Robert Gair converted to do his cutting and creasing back in 1879. A form of type or plates is placed on the upright bed of the press and after being inked is brought into contact with the sheet of paper held in position on a hinged platen. The impression is made instantaneously from entire form as the platen closes against it. These presses print only one color at a time and handle comparatively small size sheets which may be either hand or mechanically fed.

The flat-bed cylinder press derives its designation from the fact that the type or plate form is placed on a flat or horizontal bed which is carried by a reciprocating action back and forth below a revolving cylinder around which the paper stock is held. The impression, in this instance, is made only in the form of a narrow line as contact results when the bed and cylinder meet.

The diagram of the flat bed press operations in Fig. 12 shown illustrates the operation of a single color press.

Two separate bed and cylinder assemblies are made into one unit so that two colors can be printed with the paper stock being fed only once through the press. They are now usually mechanically fed and take sheets of paperboard up to 46″ x 69″.

Rotary presses are either sheet fed or web printing units and may print from one to five colors at a time. The printing forms are curved plates which are attached to a large plate cylinder by means of hooks or clamps. The paper stock travels around on the impression cylinder and the impresion is secured as contact is made between the revolving cylinders. While there are some narrow width presses for specialized operations, equipment in use can take sheets up to 52″ x 72″ in size and run at a rated maximum speed of 5500 sheets per hour. Some of these presses are constructed on a unit basis so that facilities for additional colors can be added.

Other Printing Processes

At this point it might be well to briefly describe the other processes of printing. The planographic or offset lithographic process has its image areas in the same plane as the non-printing areas but is so defined chemically that an ink receptive image from it is transferred first to a rubber blanket and then to the paper stock. The process is based on the principle that water and oil do not mix.

In place of the type or plate forms used in letterpress printing, the image is photographed on a metal pressplate, usually zinc or aluminum, and after processing is fastened around a cylinder where it is dampened and then inked. The material to be printed does not come in contact with the plate but receives the image as a result of the transfer or offset of the ink by means of an intermediate transfer cylinder. Presses of this character range upwards to those handling sheets 52″ x 76″ and are available in single or multiple color assemblies. They are mechanically fed and have rated speeds ranging up to 6000 sheets per hour.

The third method of printing is the gravure or intaglio process. The design or image is etched below the non-printing surface, forming a multitude of tiny wells that are filled with ink which is removed by passing the stock around an impression cylinder and over the ink filled cells. This is a rotary type of operation and the printing cylinder is prepared with a copper deposit which is processed to carry the image, which after being covered with ink is wiped by a doctor blade to remove the surplus. The presses for this process range from narrow specially designed units to web-fed machines handling wide rolls.

This process can also be produced on sheet-fed equipment in from one to five colors. The printing surface consists of a copper plate which after being prepared is clamped around a steel plat cylinder.

We shall resume the discussion about actual mechanical production where it was interrupted to describe letterpress presses and the other processes of

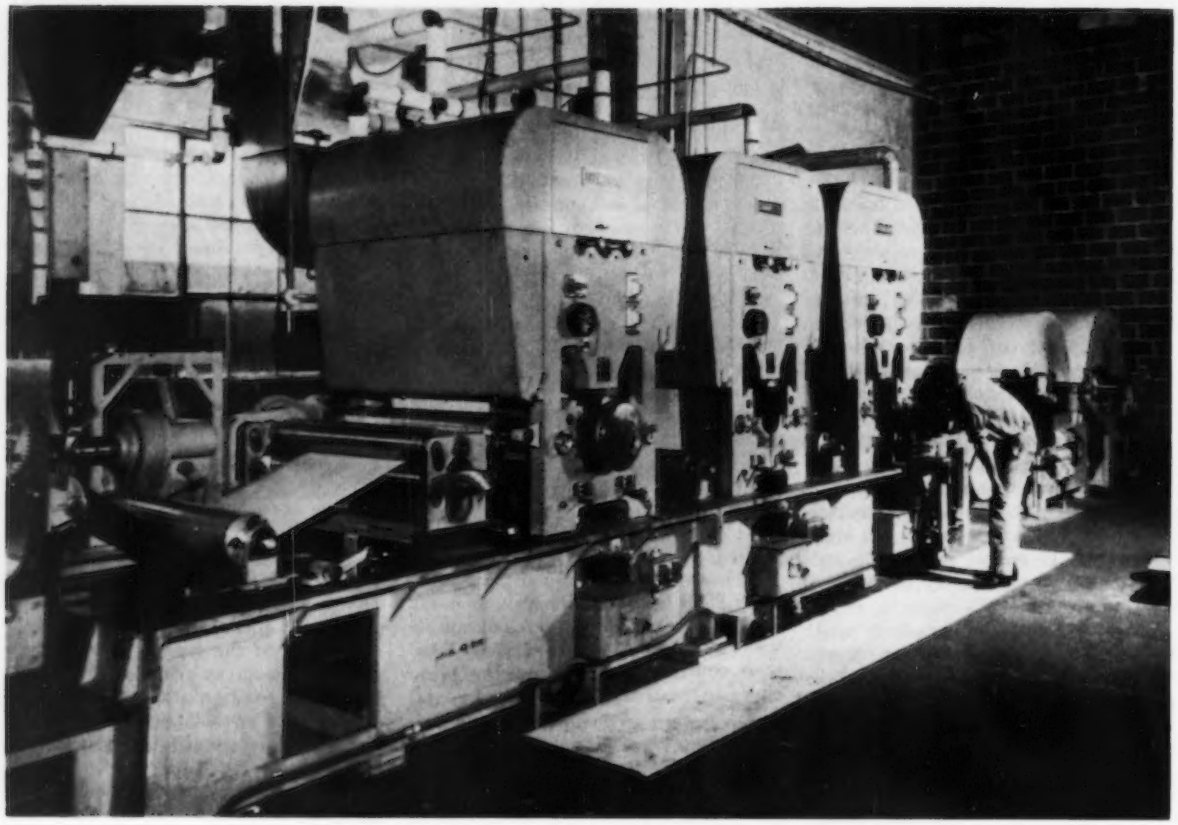


Figure 17—Multi-Color Gravure Press printing web stock

printing. The required number of sheets of paperboard for a given order, are fed or run through the printing press so that the design in its prescribed colors can be reproduced on them. As the printing sheets pile up at the delivery end of the press they are frequently sprayed with a fine powder that tends to prevent the wet ink on one sheet from smearing or transferring to the back of the sheet on top of it. Open gas flames and infra-red lamps are among other devices used to help speed up ink drying. After printing, the sheets are then ready for die cutting and creasing. These units usually operate at a slower speed than the printing units. Work produced by any printing process or, for that matter, blank stock, can be run through cutters and creasers. Reference to the preparatory steps of this operation has been made in the previous section.

Since the next operation is the removal of the scraps or skeletons around the carton blanks, special devices are sometimes attached to the cutters and creasers to assure the piling of a uniform straight load. The stripping operation is a tedious task and one which, until rather recently, was done by hand. In some plants this

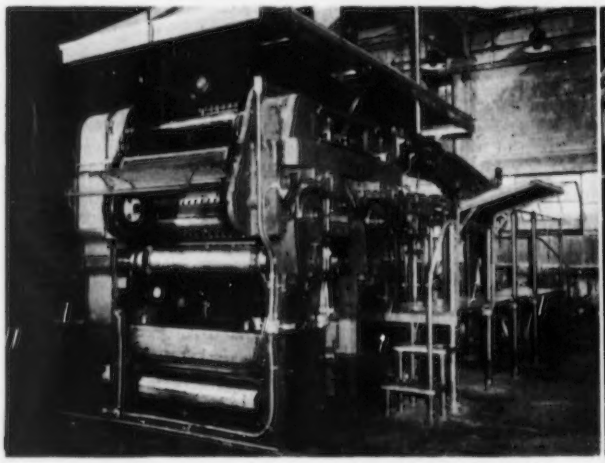


Figure 18—One-color Sheet-Fed Gravure Press printing boxboard.

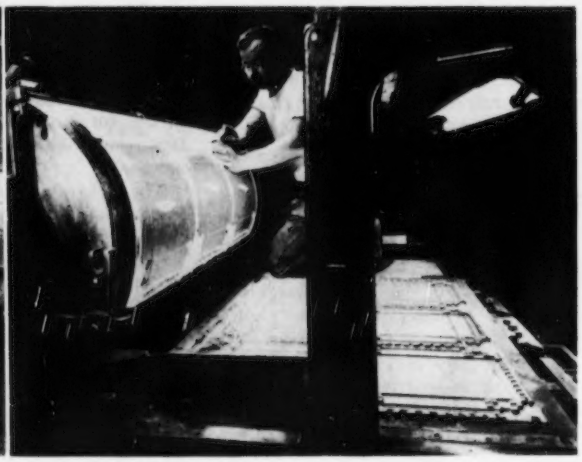


Figure 19—Makeready on a Cutting and Creasing Press

practice is still followed and the die cut sheets are accumulated at the delivery end of the cutter and where they are removed to a table for stripping. This is done manually with small hand hammers which are used to knock out the scraps. Some of the work is now being done by means of pneumatic or electric hammers which can peel off the undesired portions while the stock is still in piles. Skill is required to operate the mechanical hammers and occasionally some of the more difficult cutouts have to be removed by hand. A great saving in labor results and the work is done much faster than previously.

A still more recent development is the use of an automatic mechanical stripper incorporated with the cutting and creasing press, by which most of the scrap is automatically picked out as the sheets of boxboard are delivered. Usually only enough of the scrap is left to hold the various blanks together while the sheet is being delivered from the press. The blanks can then be separated and the balance of the pieces of scrap removed manually or by means of an air hammer. Recent developments indicate the possibility of perfecting a pneumatic unit to remove scrap automatically.

Many cartons are delivered as blanks without further operations being performed by the carton manufacturer. These blanks are used by the purchaser on automatic filling machines which form, glue and seal the filled carton.

Other types of cartons require a gluing operation. This is done by feeding the blanks through one of several types of automatic gluing machines. The blanks are placed into a feeder unit and automatically fed into the gluer. As they move through the machine a thin film of adhesive is applied to the glue lap or corners and they are folded along the crease lines by means of belts and metal folder bars. The cartons are held under pressure until the adhesive is set when they are delivered from the machine ready for tying and packing. Electrical or mechanical counting devices serve to indicate the output of the equipment and provide means for automatically counting the work as it is delivered.

(Gair Photo)

Figure 20—Cutting and creasing die for folding cartons.

Figure 21—Showing the use of an air hammer in stripping waste from carton

Other Operations

To meet the specifications of many carton buyers a number of other intermediate or finishing operations are sometimes necessary. These include laminating various paper stocks together, waxing or paraffining, bronzing, embossing, pebbling and windowing.

Like many other jobbing types of industry, there has been a tendency to develop specialized equipment incorporating or combining various production operations for the sake of economy and speed of production.

In conclusion, the folding carton industry is one of the major factors in the converting field, both as a consumer of paper and paperboard, and as a producer of billions of converted units.

I have presented figures showing the magnitude and growth of this industry. We have outlined the processes and operations used in converting raw materials into folding cartons, and we have presented some of the problems faced by this industry. I hope that my presentation has added to the general information on converting presented in this series of lectures.

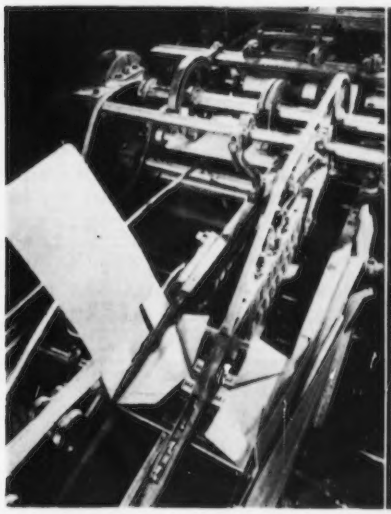


Figure 22—Carton being glued and folded on a Gluing Machine

Figure 23—Printing Press Makeready

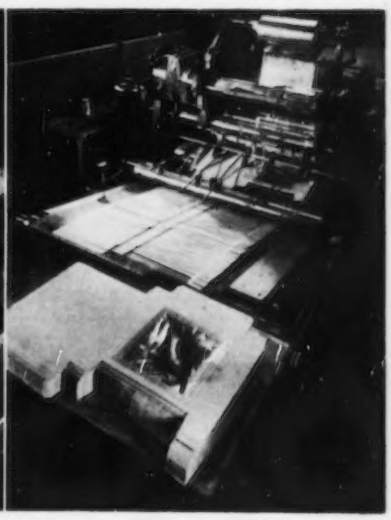


Figure 24—Transparent film being applied to "Cut-outs" in carton blanks for windows

The Manufacture of Set-Up Paper Boxes

Edward Minnard and U. K. Mejeur

Kalamazoo Paper Box Co.

In 1839 the manufacture of set-up paper boxes was started by Aaron L. Dennison in his jewelers shop in Boston. He used a shoe knife and a cobbler's bench to cut the parts and his daughters glued the box together. In 1844 the first machinery was developed by Col. Dennison, Aaron Dennison's father. This was called a "Half Macaine" and cut the corners from the boxboard. Today it is possible with the use of four machines operated by just three people to turn out a complete box every 1-½ seconds.

E. Minnard

U. K. Mejeur

Mr. Minnard is Secretary of the Kalamazoo Paper Box Co., Kalamazoo, Mich. He is a native of Kalamazoo, and began his career with the paper box company more than forty-four years ago. He has served in every department of the company, and has not confined his activity to the set-up box field. Mr. Minnard has long been a member of the Kalamazoo Chamber of Commerce and has been active in the Kalamazoo Community Chest organization. He is a member of the Kalamazoo Sales Executive Club and other civic organizations . . . Mr. Mejeur is Chief Estimator for the Kalamazoo Paper Box Co. He has been associated with that organization for twenty-seven years in various positions related to the production of set-up paper boxes.

Definition of Set-Up Boxes

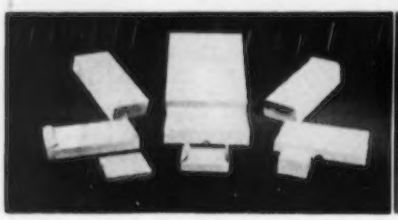
First of all, the definition of a set-up paper box is, "a stiff or rigid, non-collapsible container manufactured chiefly from paper and paperboard and delivered to the consumer ready for use." A set-up box is in three dimensional form, i.e., length, width and depth and is, in most cases, designed and manufactured to fit a specific item. This type of a box, because of its durability and strength, keep the contents which are not used immediately in good condition. By the use of inserts, one or more dissimilar items can be packaged together. There is protection afforded by set-up boxes against breakage, rough handling, dirt, pilfering and unnecessary sampling. The foregoing, together with product display have a great deal to do with sales appeal.

Inasmuch as many boxes are still made by hand as well as by automatic machines, almost any design of package can be made. There are unlimited types of boxes for the reason that the box manufacturer takes into consideration the nature of the merchandise to be packaged, methods of distribution and price which must be charged, and then designs the most effective package with these elements in mind.

Sometimes it is desirable that the box possess a higher degree of utility than appearance, in which case a simple container is manufactured by the process of selecting merely the proper weight board, determining whether the box should have extra strength built into it by the use of wire stitched corners and perhaps using either no covering paper or a very simple paper. Some boxes are waxed inside to protect the contents; sometimes grease-proof and moisture-proof papers are used. A thorough understanding of the customers' requirements is necessary to design and manufacture the proper container for his product.

Special Boxes

Some boxes are fitted with partitions or sections to package items



Mailing

Barometer

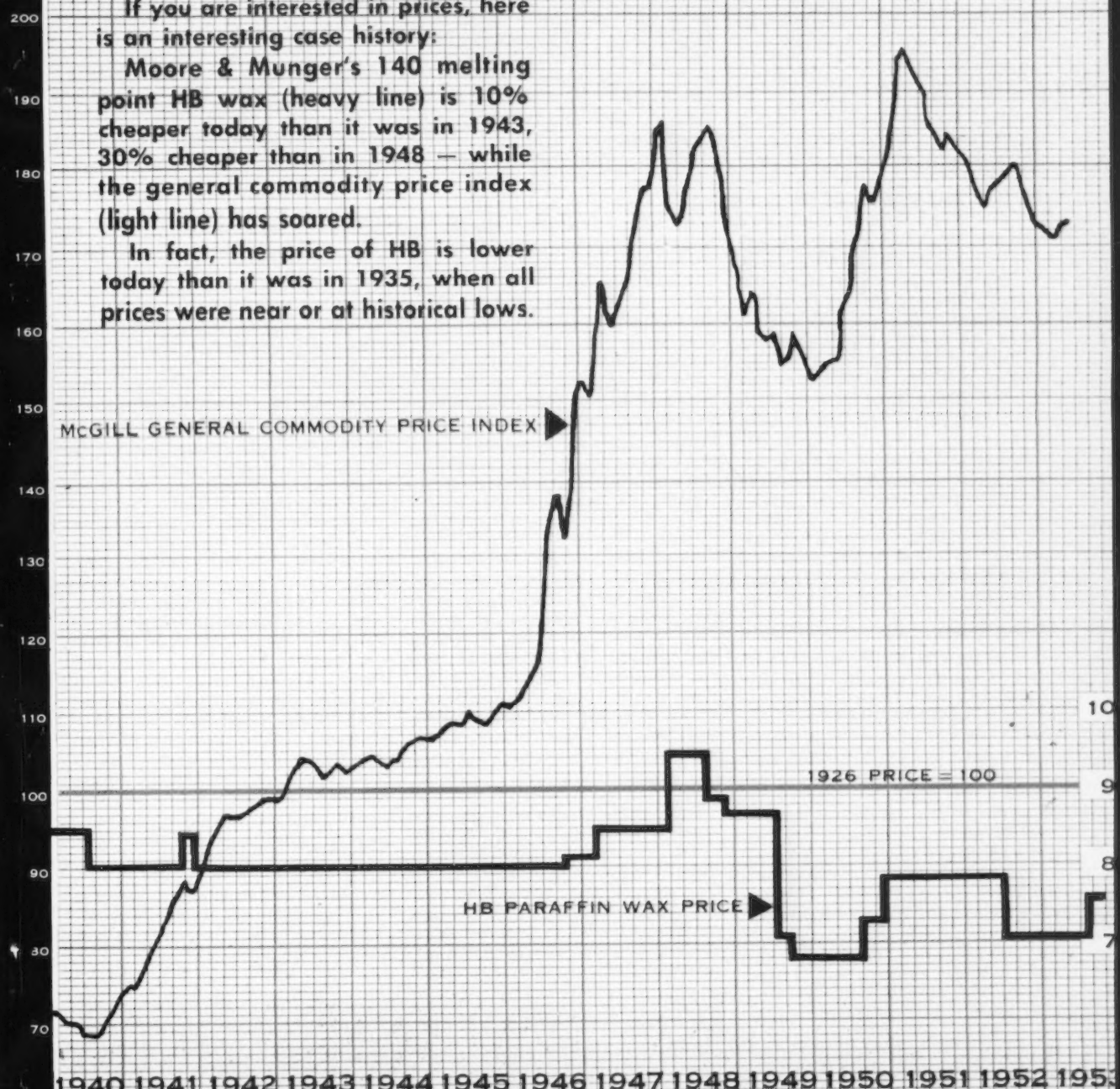
Belt and buckle

WAX PRICES: *A CASE HISTORY*

If you are interested in prices, here is an interesting case history:

Moore & Munger's 140 melting point HB wax (heavy line) is 10% cheaper today than it was in 1943, 30% cheaper than in 1948 — while the general commodity price index (light line) has soared.

In fact, the price of HB is lower today than it was in 1935, when all prices were near or at historical lows.



MOORE & MUNGER

33 Rector Street New York 6

which have several component parts; others employ die cut sections for the same purpose or to provide extra strength and rigidity. Sometimes die cut sections may be used as counting boards for games etc. Elaborate sales cases may be made from leather, velvets and other luxury materials with the end product little resembling a box; however, the same construction may be used as that used for a plain, skeleton box. In recent years boxmakers have been employing many materials in conjunction with paper and paperboard to make combination packages. Some of the more widely used materials are plastics and leathers. By the use of transparent films and sheet plastics, it is possible to display the contents of the boxes without removing the covers, thereby insuring fresh and clean merchandise at the time of purchase. Molded plastic or contour drawn plastics are also used very effectively for this type of packaging.

Luxury items, such as jewelry, are very often packaged in containers made from velvets, velour papers, leather and a wide range of embossed and fancy papers. Hot stamping with gold or silver leaf is often used to further enhance these fine papers and materials.

Mailing Boxes

There are several different types of boxes designed especially to be used as mailing boxes. This particular type of box is usually covered with a very durable paper, such as kraft paper and, in some instances, is fitted with clips which secure the box during transit in the mails. It is also a common practice to make this type of box with the paper on the ends of the box cut much longer than the depth of the box. The ends are then covered with glue when the top covering is attached to the box and by simply moistening them after the box is filled, they can then be glued over the base. Sometimes a simple skeleton box is made, covered with kraft paper and is sealed, after filling, with sealing tape.

For the purpose of adding strength and extra protection, corrugated inserts and specially cut partitions are often used. Some box makers produce these in their own plants but there are also concerns who manufacture these to order.

Stock Trade Items

All of the foregoing implies that all boxes are made to order, but there are lines of stock boxes for coordinated items such as jewelry boxes, department store boxes, gift boxes, etc. These are manufactured in large runs and sold in small lots; thereby enabling the small merchant who does not desire a package which is strictly identified with him to purchase small quantities. Also some stores, such as drug stores, variety stores, and department stores resell these boxes.

Jewelry and costume

Sample case and miniature hat boxes

Although we believe the merits of a set-up box outweigh the disadvantages, certain limitations must be recognized so they can be dealt with effectively. Freight charges on shipments of paper boxes are relatively high in comparison with other commodities; thus, it behooves the paper box manufacturer to limit his sales territory to a radius of approximately 100 or 200 miles. This, of course, is much more a factor when dealing with large boxes than small boxes. Also, set-up paper boxes take up certain space in the buyer's plant or store. However, we believe when the problem is approached from the angle that the box is more than a mere container, being a sales promotion item, an advertising medium, or an effective shipper, the merits far outweigh this limitation.

Manufacturing Methods

Today the processing of set-up paper boxes is a combination of both the old and new methods of making boxes. Some are still made by hand, much the same as they were when they first came into being; others are manufactured by some of the most intricate and modern of all machinery.

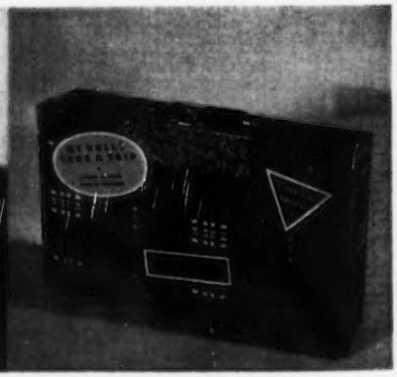
Boxboard of the non-bending type is used in the manufacture of set-up boxes. This is purchased either plain finish or mill lined. By mill lined we mean that a layer of paper has been applied to the board by the use of a cylinder machine at the board mill. This lining becomes an integral part of the whole sheet when the plies are squeezed together by the press rolls. Sometimes the board is lined at the box manufacturing plant. Such lined board makes for a cleaner and neater appearance on the inside of the box. Quite often colored lining and fancy papers are used effectively to show off the items which are packaged. In some cases the lined side of the board is used for the exterior of the package.

This lining is done by machine whereby the paper is in roll stock and the correct size of board is fed into the machine. The paper is glued and applied to the board, then passes through rollers and the paper is automatically slit at the end of each piece of board. Some lining must still be done by hand due to types of paper which cannot be run through rollers such as velour papers and heavily embossed papers.

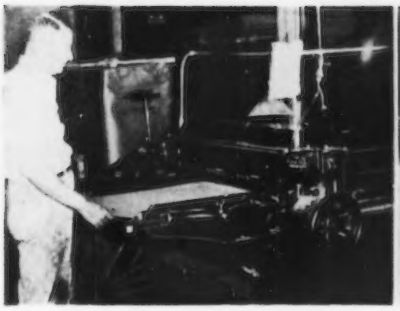
Cutting and Scoring

The boxboard is then scored to size. Scoring is done by making a knife cut on the boxboard for purpose of forming bending lines. All set-up boxes will have at least three dimensions namely, length, width and depth and it is

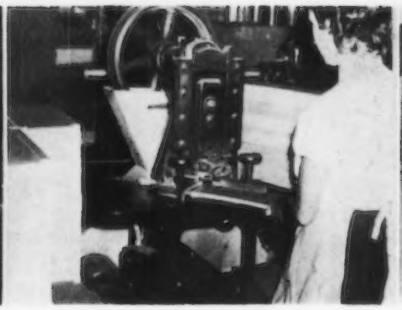
Fishing reels and watches



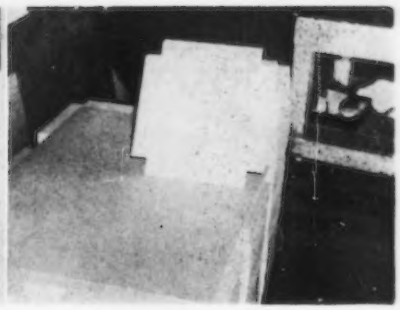
Doll carrying cases



Scoring machine



Board corner cutting



Corner cut blanks

common practice in this converting field to designate these in the above order. For example, a box 3 x 2 x 1 would be 3″ long, 2″ wide and 1″ deep. If no other dimension is given, it is assumed that the box is a full telescope box with the lid the same depth as the base. If the dimension were given as 3 x 2 x 1—½″ lid, it would mean that the base is 3″ long, 2″ wide, 1″ deep with a ½″ lid. All such given dimensions are the inside measurements and are the score measurements. Scoring is performed on either single or double scoring machines. Knives are set on these machines to make the knife cuts on a large sheet of boxboard, thus scoring more than one box blank at a time. It is necessary on a single scoring machine to reset knives for the second dimension. On a double scoring machine, two sets of knives are set and the board inserted only once with both dimensions being scored while the board is in the machine. In this particular operation a great deal of waste can be eliminated by purchasing and using the correct size of boxboard.

In some instances, for the purpose of obtaining greater strength, the boxboard is merely creased instead of scoring. This is done by using creasing rolls instead of knives. These creasing rolls crush the boxboard by pressure without cutting the fibers for the purpose of forming the bending lines.

When it is necessary to have the box waxed on the inside this is accomplished by coating the blanks with thin layers of wax at the same time they are scored.

Corner Cutting

The scored sheets are then broken down into individual box blanks and the corners are cut out by use of single or double corner cutting machines. As the names indicate, some machines cut out a corner at a time, others do two corners at a time. A machine to do this type of operation was the first machinery developed for the manufacture of set-up paper boxes.

Corner Staying

The box blanks of both base and lid are now in at flat. The next operation is the setting up of these blanks by staying the four corners. Ordinarily kraft paper tape is applied to the corners. This may be done on a machine that applies the paper stay tape to one corner at a time or by the use of a quad stayer, which is a machine for the purpose of staying the four corners of the base or lid at one time. The blanks are fed into such a machine and then automatically bent into shape and stay tape from four rolls is applied to the corners. In recent years a new type of quad stayer has been developed which employs the use of electronics and a thermoplastic stay is used instead of paper. This stay is applied by the use of heat instead of glue. In addition to the above, where added strength is desired, the corners may be also reinforced by the use of wire stitching.

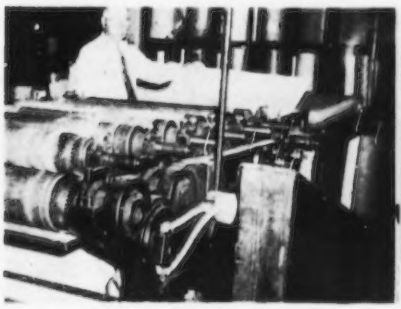
Another method of setting up the blanks is the use of banding, instead of staying. Instead of using the stay paper on only the corners, a banded base or lid has the stay tape applied to all four sides of the box. This method adds strength to the box and also tends to make the four sides of the base or lid stand straighter.

Box Lids

The lid is similarly processed and these two component parts, the base and lid, now form the simplest type of construction. As mentioned before, if the lid is the same depth as the base, the box is known as a full telescope box. If the lid is shallower than the base, it is a shallow lid box. Sometimes a shoulder box is made by inserting a neck. This may be either an extra base within the base or a board scored to form an inner shoulder or neefl. The lid of such a box would then rest upon the base. In some cases the lid is deeper than the base and a rim is then inserted in the lid which, when the box is closed, rests upon the base. Any of the above styles can be made into a flange box by gluing a slightly larger piece of board to either the base or lid or perhaps both. This type is commonly used by candy manufacturers. The lids may be thumbcut for ease in removing the lid from the base.

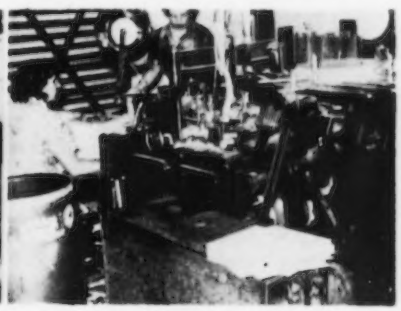
Covering

The boxes are now ready for covering or wrapping. Most cover paper is



Lining machine

Paper corner cutting



Four corner staying

Single corner staying

Hand workers

Wrapping machine

purchased in roll stock and cut to length in the box maker's plant. The paper is sheet cut to allow the maximum number of blanks from a sheet size that is easy to handle. These sheets are then trimmed to correct size; that is, large enough to cover the top or bottom, all four sides and enough extra to turn in over the edges.

The paper blanks are then corner cut on machines similar to those used for corner cutting the box blanks, although the cut on the corners differs in that the corner cut on the paper allows for a lap over on one side.

Most covering is performed by automatic machinery. The wraps (covering paper) are inserted in the machines and are carried by means of vacuum on belt through glue. These wraps, with the glued sides up, are then carried to the operator who registers or places a stayed base or lid on them and puts them in position for the plunger. This plunger forces the paper to all five sides and fingers turn in the edges of the paper. If the component part is to be thumb-cut an automatic auxiliary piece of equipment is attached to the machine and this operation is also performed. The lids and bases are processed in the same manner and very often the two parts are run on two machines sitting side by side. By the use of conveyor belts, the two parts come to one place and the boxes are lidded. There are several different types of wrapping; a box is said to be tightwrapped if the wrap is entirely glued to the box. Loosewrapping means that only the edges of the wrap are glued to the box and stripping is the term which denotes that only a strip of paper is glued to the box.

Box Variations

By the use of auxiliary machines and hand workers, it is possible to make many variations of boxes. All component parts are assembled, such as necks for the shoulder boxes, and are inserted by hand as the lids or bases are made. In order to have efficient operation; all such parts must be on hand when needed to save time, space, spoilage, etc. Many special items such as irregular shaped boxes, material covered items, hinging, etc. can be made by the use of good hand workers. These workers are used for the inserting of component parts in the bases or lids, or the attaching of hardware such as eyelets, snaps, catches, mailing clips, etc. There are automatic machines for the making of shell boxes which are boxes having a base and a four sided shell cover, but these are also in a good many cases made by hand.

The completed boxes, after being lidded, are then packed for shipment.

Sometimes in cases where the boxes might be damaged, for example, an extension edge or flange box, outer plain chipboard containers are made in which the individual boxes are first packed. If the boxes are to be transported by common carrier they are packed in corrugated cases. Many box makers deliver their own merchandise and they are then wrapped in kraft paper in bundles of a size that are convenient to handle. It is possible to nest boxes of three different sizes one within another.

Materials of Manufacture

A great variety of materials is used in the manufacture of set-up paper boxes. This depends largely on the type of box being manufactured. The prime requisite is boxboard. Most boxboard is made to standards set up by the National Paperboard Association. The most commonly used boxboard is plain chipboard which is of relatively low density and is made from waste papers. Plain chipboard is made in four standard finishes and most boxmakers use a #2 finish which is a medium pressure for fair surface and sheetage. As explained before, a vat lined board is sometimes used. There are other types of boxboard used in some cases. A few of these are strawboard, newsboard and kraftboard. Strawboard is made from straw—rigid but not susceptible to high finish and for the set-up box trade is usually lined with paper. Newsboard is made from printed news. Kraft board is made of kraft pulp in various thicknesses with either a dry or water finish. Its chief characteristics are its strength and bending qualities.

There are several important factors to consider in the purchase and use of boxboard. The first is the use of the correct caliper of board. The caliper is the thickness of the board expressed in 1/1000 of an inch. It is necessary to determine weights of items to be packaged in order to decide what caliper board should be used. Also, it is necessary to purchase the correct size of sheets to obtain the maximum number of box blanks with a minimum of waste. It is also necessary to bear in mind the grain of the board so that the long grain of the board will, in most cases, be used for the length of the box.

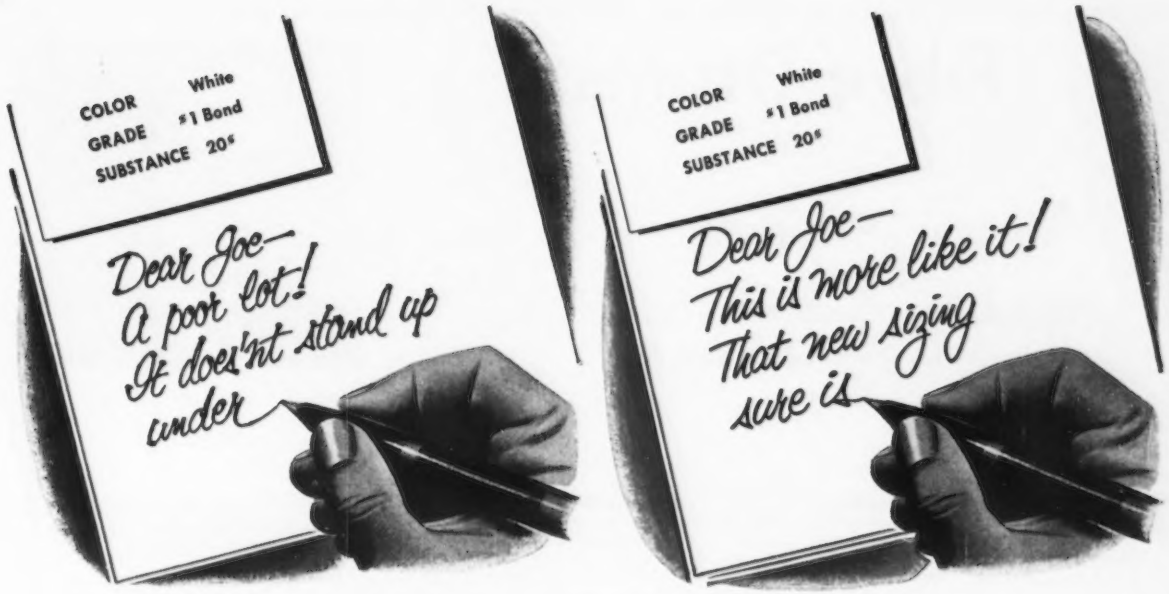
Cover Papers

There are various types of papers which can be used for covering. This depends upon the purpose of the box and can range from kraft to the most highly decorative paper. Also these wraps or labels may be printed, hot stamped with gold or even trademarked to tie in with other items used by the same consumer.

Here it is necessary to determine the purpose of the box; whether it is a utility item such as a mailing box or a sales promotion item. Cloth and leather may be used instead of paper. This again depends upon the use of the box.

There are many other items used in the manufacture of boxes; stay paper, cotton wadding, glue, corrugated cases for shipping, hardware, ribbon and many other requisites for attractive and purposeful boxes.

The foregoing is only a very brief resume of the purpose, planning and processing of set-up paper boxes, for the details, materials and ideas are as endless as the variety of boxes which can be manufactured.



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Fibre Drums

Glenn Mather

Technical Adviser, Continental Can Co., and Secretary, Fibre Drum Manufacturers Assn.

Glenn Mather is secretary of the Fibre Drum Manufacturers Assn. and technical adviser to the Continental Can Co., Inc., Fibre Drum Div., New York. He is a graduate of the University of Chicago. His business experience includes the manufacturing of paperboard, corrugated fibre boxes, folding boxes, paraffined cartons, round nested containers for moist foods, envelopes, set-up boxes and fibre drums. He served three years as director of research for the fibre box industry and from 1941 to 1943 served the United States Government as a pulp and paper industry specialist. He is a member of the Packaging Institute, the Maritime Assn. of the Port of New York, and is transportation vice-president for the Eastern Div., Society of Industrial Packaging and Materials Handling Engineers. He is presently a member of the Packaging Industry Advisory Committee of Columbia University and is a regular lecturer in a graduate course on packaging engineering at that institution.

General Characteristics and Principal Raw Materials

Fibre Drums are cylindrical shipping containers. From strictly a utility viewpoint, there are six principal characteristics which may be briefly summarized as follows:

1. Rugged durability—Protection for high value products—Provides extra assurance of safe delivery.
2. Tare weight — Relatively low — Saves freight.
3. Clean, smooth surfaces—Inside and out
4. Easy to close—Open-and-reclose.
5. Many sizes for product variations.
6. Many styles and materials for special requirements.

Drums are classed by transportation authorities as fibre drums if the sidewalls are made from fibre, regardless of the type of materials used in tops and bottoms. There are now four well-known types: 1) all fibre; 2) fibre sidewalls with metal top and bottom; 3) fibre sidewalls with wood or plywood top and bottom; and 4) fibre sidewalls with top of one material and bottom of another. Some of the well-known variations are: 1) metal top and metal reinforced fibre bottom; and 2) plywood top and metal bottom.

The first table in Uniform Freight Classification Rule 41, Section 12, shows the fibre drum industry's minimum standards for seven weight and capacity groups — for rail, air, and motor freight shipments—of non-dangerous dry or solid articles. These same identical standards are authorized in Federal Specifications UU-D-723—Drums, Fiberboard (Domestic Type). A Federal Specification is for use in government purchasing and is frequently used by private industry for non-government buying.

Some of these subjects will be presented more fully during this lecture, but a review at this stage of this table which has been in effect for many years with very few changes, will provide basic information on the various material specifications.

The principal raw materials used in making fibre drums are paperboard and adhesives. The industry also uses between fifty and one-hundred-thousand tons of steel each year—for reinforcement bands or hoops—and in certain types of drums, the top or the bottom, or both, are made of steel. Wood or plywood are used by certain manufacturers for tops and bottoms. Plastics combined or laminated with paperboard or processed wood have been considered, but up to the present time have been regarded as too costly for commercial use, except in the form of a film or coating.

History and Growth of the Fibre Drum Industry

When invited by a long-distance 'phone call to come to Kalamazoo to talk to you about fibre drums, the thought flashed through my mind that right here in this area is the birthplace of the fibre drum industry—at least the earliest record yet discovered.

Perhaps it will seem more authentic if I read a few sentences from the book published in 1946 entitled "Paperboard and Paperboard Containers—A History" by Harry J. Bettendorf. This published record is based upon my own research and data which I gave the publisher, developed in interviews with several "old timers" about eight or nine years ago.

"Earliest record of a cylindrical fibre container for shipping purposes was a small plant, whose name has not been learned, which was established between 1900 and 1904 at Sturgis, Michigan, for the manufacture of all-fibre cylindrical drums for cheese of two diameters—12 inches and 14 inches—and depth of about 5 inches. It is known that the fibreboard was furnished by Monroe Binder Board Company, Monroe, Michigan. The top and bottom headings were attached to the body by metal rivets. The cover was fastened by three metal lugs.

"This company has particular interest because it is traceable, indirectly, as will be related in more detail later, to The Container Company, one of the pioneer developers of the fibre drum. Equipment consisted of hand expanders, which held the body in cylindrical form while the edges were joined together, and foot power machine for riveting the headings.

"The equipment from the Sturgis, Mich., drum plant was sold in 1904 to the Lewis Fibre Box Co., Toledo, Ohio, which was formed on September 12, 1904. On May 23, 1907, Lewis Fibre Box Co. was taken over by Toledo Fiber Package Co., newly formed; and ten years later, Toledo Fiber Package was purchased by The Container Co. (now at Van Wert, Ohio, and operating as the Fibre Drum Div., Continental Can Co., Inc.)..... .....initially all fibre drums or

RULE 41 SECTION 12

UNIFORM FREIGHT CLASSIFICATION NUMBER 1

EFFECTIVE MAY 30, 1952

Barrels, Drums, Pails or Greaseproof-Waterproof Tubs.

Section 12. (a) Subject to provisions of Rule 5, and unless otherwise provided in separate descriptions of articles or in Agent H. A. Campbell's Freight Tariffs referred to in Rule 39, when the following requirements and specifications are complied with ratings or rates applying on articles in wooden barrels, drums, pails or tubs will also apply on the same articles in fibre barrels, drums, pails or tubs of the styles described in this section, respectively.

Unless otherwise provided in separate descriptions of articles, when articles are tendered for transportation in fibre barrels, drums, pails or greaseproof-waterproof tubs and the requirements and specifications of this rule are not fully complied with, freight charges will be increased 20% LCL or any quantity and 10% CL with minimum increase of ‡3¾ cents per 100 lbs. above the charges applicable on such shipments in boxes that do conform to the provisions of this rule.

Fibre Barrels, Drums, Pails or Tubs for Dry or Solid Articles.

(b) Fibre barrels, drums, pails or tubs for dry or solid articles must conform with the following requirements and specifications:

Maximum Limit		Side-Wall Test per Square Inch (Pounds) (See Note 1)	Minimum Requirements Tops and Bottoms (each)				
			Fibreboard outer ply Waterproofed			Wood Thickness	
Weight of Contents (Pounds)	Capacity (Gallons)		Thickness (Inches)	Test (Pounds) (See Note 1)	Steel (U. S. Gauge)	Solid (Inches)	3 or more ply plywood (Inches)
30	15	250	.080 or .060	200 or 400	30	3/8	1/4
60	30	350	.120 or .090	300 or 600	30	1/2	3/11
125	45	500	.160 or .120	400 or 800	28	1/2	3/8
150	55	600	.160 or .120	400 or 800	28	1/2	3/8
200	65	700	.180 or .120	500 or 1000	26	1/2	3/8
300	75	800	.200 or .160	550 or 1100	26	15/32 (See Note 2)	7/16
400	75	900	.240 or .200	600 or 1200	24	15/32 (See Note 2)	7/16

Note 1.—When more than single ply, test may be determined by multiplying test of single sheet or ply by the number of laminations or plies.

Note 2.—Where the fibre shell of drum is provided with a formed inside bead to support the wood head and a steel rim holds the head in place and is locked in an external groove of the fibre shell, solid wood heads may be not less than ½ inch thick. Such ½ inch heads must be reinforced by covering both sides with Kraft liner board not less than .012 inch thick securely glued throughout entire area of contact with a glue or adhesive which cannot be dissolved in water after the film application has dried.

(c) Sidewalls may be constructed of fibreboard of single ply with outer face waterproofed and the ends of the fibreboard forming joint or overlap must extend at least 2 inches beyond beginning of the overlap and must be firmly glued together throughout entire area of overlap and such overlap must be reinforced by metal rivets, staples or stitches not more than 6 inches apart or must be fastened by a double row of metal rivets, staples or stitches not more than 2 inches apart in each row, or secured by a barbed steel strip not less than gauge 22 and not less than 1 inch wide extending entire length of joint with barbs pressed through fibreboard and clinched on inside.

(d) Sidewall may be constructed of more than one ply not spirally wound, no single ply to be less than .012 inch in thickness with outer ply waterproofed and all plies firmly glued together.

‡Subject to Item X-175.

pails were made from built-up or laminated sheets, which were then formed into cylinders, the seams generally held by metal strips riveted or stitched to the sidewalls to hold the joint or seam together. This contrasts with present methods of making drums with a series of convolute windings, which produce drums without side seams."

All shipping containers are now covered in rail freight regulations, Rules 40 and 41. The earliest mention or authorization in freight regulations for the use of fibre drums was in 1910. However, the early types of drums were crudely made and the industry made very slow progress until about 1925. Two events in the middle 1920's made possible certain improvements which not only led to making better small capacity drums, but also led to the introduction of larger drums to correspond with standard wood barrel sizes such as 30, 40 and 55 gallons.

The use of the term gallons in stating drum capacities is somewhat misleading to the uninitiated. The gallonage refers to dry measure—not liquid, although certain types of large drums have been approved for liquids in the last two years. Products such as small metal parts are not measured in gallons so the trade usually states drum capacities in two ways—in gallons and in cubic inches. The fibre drum capacity range in the last decade has been:

Minimum: 173 cubic inches or ¾ gallon.

Maximum: 10 cubic feet or 75 gallons.

Now the two events or developments which gave the fibre drum industry a big lift in the mid 1920's were:

1. Improved paperboard: cylinder kraft made from southern pine came on the market in 1923 and 1924; fourdrinier kraft first became available in 1927 and 1928. These materials possessed a fair degree of uniformity and a more favorable weight, cost and performance ratio than jute board made largely or entirely from miscellaneous types of waste paper.

2. Convolute winding machinery was developed. Previously the drums were made from sheets of laminated paperboard generally known in the box industry as solid fibre. The sheets for the drum sidewall were formed into a cylinder with either a stitched overlap joint or a butt seam covered with a metal strip secured by metal prongs imbedded in the paperboard, or by other means.

Important improvements quickly followed in cover and closure designs, and in methods of integrating the sidewalls with the top and bottom sections. In other type of containers such as fibre boxes and metal cans there is a fair degree of uniformity in design and construction—but the fibre drum industry is still in the pioneering stage in this respect—each manufacturer has somewhat different styles of construction and different fabricating equipment. Anyone entering the fibre drum industry must build his own convolute winder or have it built to his own design. The same situation prevails with some of the other equipment required for making drums.

The number of drums used per day is approximately 70,000 and the number per year is now about 25 to 26 million according to U. S. Department of Commerce statistics. The dollar value averages somewhere from a dollar to two dollars per drum, although small sizes may cost considerably less than half a dollar.

There are no statistics available on average size produced or average value per drum, but these statements will provide a general picture for those who are statistically minded. In general, the fibre drum industry is still one of the smallest, one of the most technical and I might add, one of the least understood branches of the container industry. But during the depression years in the 1930's and in the war and post-war years, the industry has enjoyed steady growth, with new uses being added each year.

Manufacturing Data

Diameters range from 8 inches up to 23 inches. Many requests have been received for diameters larger than 23 inches, but for general shipping and storage purposes, the industry has held to this 23-inch maximum. Three types of sidewall construction have been authorized in Rule 41, Section 12, but two of them are seldom seen in actual use.

One of the earliest types consisted of laminated solid fibreboard formed into a cylinder, with joining edges (or ends) overlapping at least two inches, and secured by any one of various methods — commonly referred to as "lap seam drums."

Another type of construction which was first authorized as a war-time expedient in 1942, particularly for the paint industry, was the spiral wound tube. Although spiral winding can be done at higher speeds and at less cost, the strength required for shipping hazards was found lacking. Spiral-wound drums soon became obsolete. The authorization to use spiral-wound drums is now being cancelled from the rail freight regulations, effective on January 14, 1953. The inherent weakness of the spiral-wound type of construction was partially recognized by the freight authorities ten years ago, and spiral-wound fibre drums were always limited to a maximum contents weight of 50 lbs. and a maximum capacity of five gallons.

Over 99 per cent of the fibre drums at this date are made with convolutely wound sidewalls—wound on a mandrel, which is built with either an adjustable segment or some other means for easily ejecting the fibre cylinders from the mandrel. Federal Specification UU-D-723 refers to the convolute wound construction as "continuous without joints."

In the making of convolute wound drums, the number of plies (thickness not less than .012 inch) is not determined by a combined thickness specification. The ultimate objective is, how much bursting strength per square inch is needed to meet or exceed the sidewall strength specified in *Table I* for the weight to be packed in the drum — or the capacity required — whichever requirement is higher. For example, if a 40 gallon drum is being made to carry 350 lb., the sidewall minimum test must be at least 900 lb., whereas a 40 gallon drum to carry 110 lb. would require a minimum sidewall test of only 500 lb.

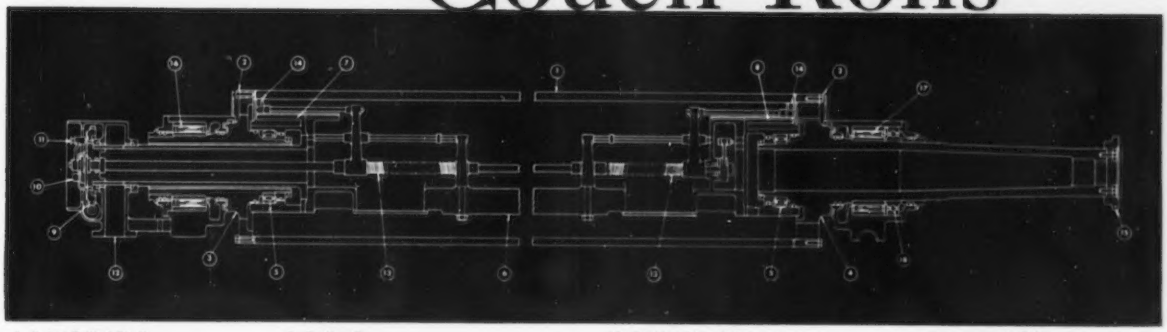
For products of high density, drum manufacturers build drums to exceed the minimum strengths in the Rule 41 Table by a substantial margin, according to a self-imposed standard, based on their own individual experience record of what is needed for satisfactory performance.

One popular capacity or size is the 41 gallon drum for 200 lbs. of powdered milk or for 200 lbs. of various chemicals in either powdered form or in crystals. According to the Table, the minimum sidewall test for a drum to carry 200 lb. would be 700 lb. per square inch. But if the shipper expects to ship a part of his production overseas, then the drum manufacturer would usually recommend a drum built to carry 400 lb., even though the actual weight of contents would be only 200 lb. For the 400 lb. specification, the sidewalls would be made of enough plies to test 900 to 1000 lb., and certain other changes would be made to add strength to the drum, to withstand overseas transportation hazards.

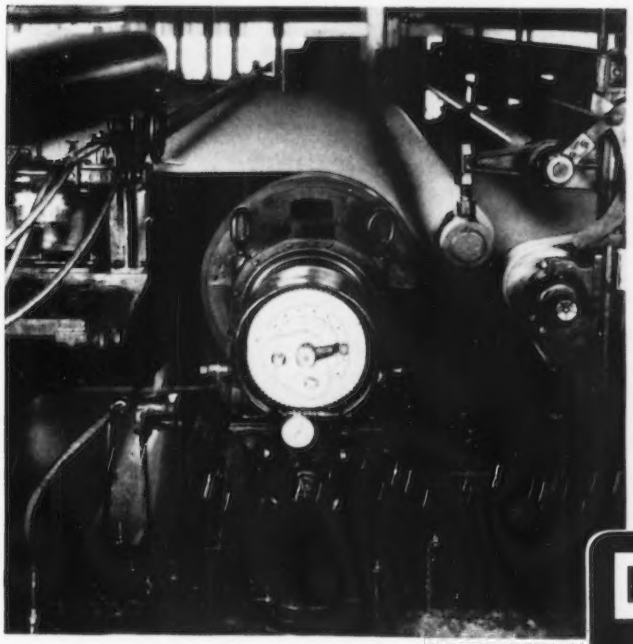
Fibre drum manufacturers use kraft liner for the sidewalls, ranging in caliper from .012 up to .016 inches. If kraft liner is not available, some manufacturers can substitute jute, involving more combined thickness to meet the minimum test requirements. However, the forming dies generally used in assembling the bottoms with the sidewalls are of such a nature that large variations in thickness cannot be handled.

THE KEY TO EFFICIENT WATER REMOVAL ON FOURDRINIERS

Downingtown Suction Cantilever Couch Rolls



1. Spiral Drilled Shell
2. Alloy Steel Shell Studs
3. Front Head
4. Rear Head
5. Internal Roller Bearings
6. Suction Box
7. Front Head—Suction Box
8. Rear Head—Suction Box
9. Worm Wheel Gear
10. Front and Rear Deckle Gears
11. Packing Strip Adjustment
12. Suction Elbow
13. Front and Rear Deckle Screws
14. Deckle Heads
15. Coupling to Drive
16. Front Main Bearing
17. Rear Main Bearing
18. Thrust Bearing



Downingtown Suction Cantilever Couch Roll showing adjusting mechanism and hood guard.

Because of Downingtown's long experience with the principle of water removal by the suction method, their Suction Cantilever Couch Roll is recognized as "standard" in the paper industry. The cantilevering feature is important because it permits easier and faster wire changing.

Downingtown Suction Cantilever Couch Rolls are furnished with suction connections either front or rear . . . and with single or multiple suction box openings. The experience of many mills shows that these Suction Cantilever Couch Rolls give long and efficient service and require a minimum of maintenance.

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An assortment of various types of fibre drums.

In the manufacture of 200 test corrugated fibre boxes, the thickness of facings ranging from .014 kraft to .016 jute usually does not involve any serious problems. A difference of .002 in the outer facings plus a difference of .002 in the inner facing, makes a total difference of only .004—equivalent to 1⅓ thicknesses of ordinary newspaper. But if a fibre drum manufacturer is using liner which has a bursting strength of 95 to 100 lbs., he will require nine or ten plies to develop a sidewall minimum test of 900 lbs. for a drum to carry 400 lbs. Ten plies of .014 kraft would make a combined thickness of .140 inch, plus an additional allowance for adhesive between each ply, whereas ten plies of .016 jute would make a combined thickness of .160 inch, plus the adhesive allowance. This difference of .020 would necessitate a different set of forming dies or chucks to make each drum diameter.

One of the footnotes in *Table I* states that when the construction involves more than one ply (either in sidewall, top or bottom) the test "may be determined by multiplying the test of a single sheet or ply by the number of laminations or plies." This provision was first included in the rail regulations several years ago when a large percentage of the Mullen testers at freight terminals and other locations were built to test up to a maximum of 600 or 650 lbs., which was ample for most paper mills, paper distributors, and for testing the 200 lb. and 175 lb. test fibre boxes in general use at that time. As a practical expedient, permission to determine the test of fibre drums by testing one ply and multiplying by the number of plies became a standard test procedure.

Most of the bursting strength testers in general use today will test up to 1000 lbs. or more, but as yet, no effort has been made to cancel this old provision. The multiple ply method of calculation favors the shipper and the carriers and is generally regarded as a handicap accepted by the drum manufacturer. It is well known that when several sheets or plies are laminated together and then are tested as one unit, the bursting strength is almost invariably greater than the result obtained by multiplying the test of a single ply by the number of plies.

As stated previously, each drum manufacturer has developed individual preferences and techniques for tops and bottoms. Many steel drums have only a small opening at the top—or perhaps a nine-inch diameter opening. Over 99 per cent of the fibre drums used today are made with full open tops—for easy filling and emptying.

Regardless of whether the tops and bottoms are made of fibre, steel, solid wood, or plywood, as authorized in the regulation, close attention must be constantly given to producing parts which are uniformly accurate in dimensions and properly fabricated to secure strong tight fitting integration with the sidewalls.

The word "chime" is often used in connection with wood barrels, metal, fibre or plywood drums. This term has been defined by and for the fibre drum industry as follows: The circumferential edge at top and bottom of a drum. When the drum is made with recessed top or bottom, the chime is that portion which extends beyond the top or bottom heads.

Many of the methods of fabrication and styles of construction are covered by patents. For this reason, no attempt will be made here to present cross section views of each of the many types. However, any user or prospective user of drums can usually secure actual cross sections upon request to the drum manufacturer.

A basic requirement is stated concisely in the Uniform Freight Regulations, Rule 41, Section 12(e)—

> "Tops and bottoms must be so fastened to sidewalls as to provide a tight seal and withstand ordinary handling and shipping without showing signs of sifting or loss of any of contents."

A similar wording of this requirement is stated in Federal Specification UU-D-723—Section 3.3.3—

> "Tops and bottoms of Types I and II drums shall be fastened to the sidewalls with adhesive, metal fastenings, or tape or a combination of these methods in such a manner as to provide a tight seal and closure to withstand handling and shipping without evidence of sifting or loss of contents."

Since fibre drums have been used in recent years for many non-sifting products, such as rolls of X-ray and photographic film, rolls of barrier materials, rolls of transparent packaging materials, metal products, machine parts and instruments, it would now be more realistic to confine the siftproof requirement to drums for powders, flakes, crystals, or granular materials.

Closures and Sealing Discs

Methods of closing fibre drums vary considerably. There are no detailed specifications regarding what types of closures may be used. The two quotations in the previous section on "Construction Data" are the only limiting factors in the Federal Specification and in the Uniform or Consolidated Freight Regulations, Rule 41, Section 12, which can be applied to closures.

However, with few exceptions, each type of drum is built for only one type of closure. Unlike fibre boxes where a shipper may choose whether to coat the inner flaps with adhesive, or use sealing tape, or use both tape and an adhesive between the flaps, plus perhaps wire tying or steel strapping—the fibre drum user must take into consideration the type of closure he prefers, when he chooses the type of drum

he wishes to adopt for his product and his type of usage.

All of the following types of closures or fastening devices are in general use: metal bands, lugs, rings, clips, nails, wire staples, stitching, kraft sealing tape, cloth sealing tape, cloth backed pressure sensitive tape, adhesives, and two distinctive types of expanding metal locking bands. For some very sensitive products rubber gaskets may be used.

Sealing discs of various materials are generally used in the closing of fibre drums to provide a tight seal. In fact the sealing disc serves in three ways: 1) as a protective material or barrier between the top of the drum and the contents; 2) as a gasket to make a very tight seal; and 3) as additional protection to prevent contamination of the contents when the cover is first removed at destination.

Among the materials commonly used for sealing discs are plain kraft—waxed or unwaxed; creped or crinkled two-way stretch impregnated kraft; greaseproof papers; polyethylene; and others.

Sealing discs are a few inches greater in diameter than the drum to provide the desired amount of overhang around the perimeter. The usual procedure at time of closing is first, to place the disc over the open top of the drum; second, to place the top section or cover in proper position, making sure that it is well-seated; and third, to fasten the cover securely by whatever means is recommended by the drum manufacturer.

Lap Seam Drums

Fibre drums made with the lap seam construction have been discontinued for dry and semi-solid articles. This construction has been used very widely, however, for hot-poured materials which solidify when cooled to ordinary shipping and storage temperatures.

Fibre Drums for Hot-Poured Materials That Solidify on Cooling

Drums for hot-poured products which solidify upon cooling may be either convolute wound or "lap seam" type but they have certain distinctive characteristics. They usually have an interior coating or treatment—sometimes called "free stripping treatment"—to prevent the bonding of the fibreboard with the hot contents.

Such drums do not require the "easy to open and reclose" feature commonly desired for other types of fibre drums, since it is customary for the user to cut or chop the container open with an axe, or some other cutting device, regardless of whether the container is a light gauge metal drum or a fibre drum.

In this group of hot-poured products are various grades of asphalt (used for roofing, insulating compounds and roads), waxes, rosins and synthetic resins. Only two sizes of drums are generally required—55 gallon and the popular 100 lb. unit which is approximately 13 gallon.

Authorization for some of these drums with special weight limits higher than 400 lbs. will be found in Consolidated and Uniform Freight Classification's special "Package Descriptions" in the last section of the book, and are not governed entirely by Rule 41, Section 12.

Users of fibre drums for hot-poured products report two advantages—1) less risk of workers suffering cut hands and other personal injuries; and 2) fibre drums after removal of contents can be disposed of easily by burning, whereas empty light gage metal drums usually have to be collected and hauled away to some distant location.

Fibre drums also make possible an impressive saving in steel. One million light 28 gage steel drums of the type used for asphalt and waxes would require 8,000 tons of steel, while all-fibre drums would require none, except for stitching wire.

Fibre Pails

Closely related to the straight-sided fibre drums are the taper-sided fibre pails. At present there are only two manufacturers of fibre pails—both located in Wisconsin. Fibre pails have long been regarded as part of the fibre drum industry by the Fibre Drum Manufacturers Association, by the U. S. Department of Commerce, and other federal agencies.

At present there are only three sizes of fibre pails being manufactured, although additional sizes could be added if the demand indicated assurance of continuous volume. Special dies are required for each size. Sizes now being produced for dry or solid articles are 3½ gallon; 5 gallon; and 6½ gallon. They may be purchased with or without bails.

Some of the products commonly shipped in fibre pails are bulk candy, printing inks and fortified or medicinal feeds for livestock.

Fibre pails are covered by the same freight regulations in Rule 41, Section 12, as fibre drums. See Table I for minimum specifications for tops and bottoms—and sidewall test.

Fibre Drums for Semi-Liquids or Other Articles Not Dry

The freight regulations for this class of drums are set forth in Rule 41, Section 12 (f) and (ff), and in Federal Specification UU-D-723, Section 3.3. A few interesting modifications are now under consideration. What is a semi-liquid and what is a semi-solid? Should these terms be used synonymously or interchangeably? If the container requirements are to be higher for liquids than for semi-liquids, how may shippers, carriers and container manufacturers know when to classify a product as a semi-liquid and when to use the higher requirements for liquids?

Uniform Freight Classification Rule 41, Section 12 (ff), contains this requirement: "Fibre drums for semi-liquids or other articles not dry must be so treated, processed or inside proofed as to prevent any absorption of contents by sidewall, tops or bottoms."

Federal Specification UU-D-723, Section 3.3, drums for semi-solid materials is more explicit: "Drums shall be treated, processed, or inside-proofed so as to prevent any absorption of contents by the sidewall, top, or bottom of the drum and which will not adversely affect or be adversely affected by the contents."

In addition to defining or clarifying the term "semi-liquid," the regulatory bodies now have under consideration the addition of a few words to specifically authorize the use of a plastic bag liner, such as polyethylene, saran or other materials in lieu of the treatment, processing or proofing of the interior of the drum to prevent absorption of contents. At present the use of plastic bag liners is generally accepted by most of the carriers, but occasionally a freight inspector will strictly interpret the current wording to mean that regardless of the presence of a separate plastic bag liner, the drum itself must be treated or processed to resist absorption.

Fibre Drums for Liquids

The freight regulations in Rule 41, Section 12 (fff), have authorized for many years the use of fibre drums for liquids, subject to the following limits: Maximum Capacity—5 gallons plus sufficient outage; and Sidewall Test—850 lb.

Until 1951 no fibre drums were sold for commercial use which could be used satisfactorily for liquids unless some waterproof container (metal, glass or plastic) was placed inside of the drum. The drum sidewalls and the

major areas in top and bottom could be made impervious to liquids but no satisfactory method was developed to integrate the sidewall with top and bottom without some leakage, when subjected to ordinary handling in transportation and storage.

Uniform and Consolidated Freight Regulation Rule 5, Section 2(a), reads as follows:

> "Articles which are easily broken, such as glassware or earthenware or articles in glass or earthenware containers, must be adequately protected within the shipping containers against damage or breakage by liners, partitions, wrappers, excelsior or other packaging material."

To comply with this rule it has been fairly easy to adapt the use of fibre drums for liquids in glass containers not exceeding five gallon capacity, by surrounding the glass container with cushion material. The type of cushion material most commonly used is single faced corrugated. Coils or small rolls of this material, without die cutting expense, can be used in the top and bottom of the drum, and five plies or more are used to cushion the sides of the glass container. Each large bottle may contain liquids valued at hundreds of dollars, but shippers who have used fibre drums of this type for many years report excellent results. In the last two years real progress has been made in building fibre drums which out-perform wood barrels for certain liquids, the contents weighing up to 200, 300 or 400 lbs.

Packaging engineers who have had container experience with liquids recognize that in addition to the leakproof factor, much greater strength is required for 400 lbs. of liquids than for 400 lbs. of dry solids or powdered material. This important difference was described by my friend E. S. Schneider of Philadelphia in the following terms:

"Packaged liquid products are never at rest—in storage they endeavor to escape confinement by seeking a weakness in the container and in transit or during handling, their continual movement sets up a hydrodynamic impact or ram action. Optimum stresses leading to failure exist when the position of the container is changed suddenly, such as being dropped or pushed over from an upright position. Packaged granular products, on the other hand, generally might be considered to be quite content with their environment and even when the container is punctured or ruptured, the amount that escapes is limited to its particular angle of repose."

The pioneers in the fibre drum industry have always followed a conservative sales policy and new types of drums are seldom placed on the market until they have been well-tested over a long period. The drums for liquids and emulsions over five gallons and up to 50 gallons, are being offered on a restricted basis and generally under special shipping permits issued by rail and motor freight carriers, while an experience record is being compiled.

Fibre Drums for Dangerous Articles

Certain explosives and chemicals, such as poisonous insecticides, require special types of containers. For complete information see Agent H. A. Campbell's Tariff No. 8 which is applicable to rail freight and rail express—or, Motor Carriers Explosives and Dangerous Articles Tariff No. 7.

These two traiffs are almost identical and both are based on Interstate Commerce Commission "Regulations for Transportation of Explosives and Other Dangerous Articles by Rail Freight, Motor Freight, and by Water."

In these tariffs fibre drums are covered by Specifications 21-A and 21-B. Under both of these specifications the maximum authorized capacity is 55 gallons and the maximum authorized weight is 200 lb., except for certain products which are authorized for higher weights. The sidewalls must be convolutely wound, the plies to be secured together with adhesive and at least .010" thick.

In Specification 21-A, the sidewall for a drum to carry 200 lb., must test 1100 lbs., calculated by multiplying the test of the single sheet by the number of laminations. In Specification 21-B, there are no specifications for the bursting strength but the performance tests are higher.

Each drum manufacturer is required to register his specifications with the Bureau of Explosives, 30 Vesey street, New York 7, N. Y. "Changes in construction (drum and closure) differing from specifications thus filed must be approved by the Bureau of Explosives before authorized for use."

Barrier Materials, Drum Linings, Coatings and Treatments

Barrier materials may be used to keep water vapor in, or out of, fibre drums according to the characteristics of the contents. Certain types of drums do not have water vapor tight closures or tops and bottoms, and in these types it is general practice to use a separate vapor proof bag liner, such as, polyethylene or Saran, with a vapor proof seal.

A substantial percentage of fibre drums are manufactured with barrier material fabricated in the sidewalls, tops and bottoms, for the protection of sensitive products. However this increases the cost and the barrier is omitted from drums for products which do not require this extra protective feature.

The most popular type of barrier is asphalt laminated kraft. Other and more costly types of barriers may be used according to the characteristics of the product to be packed. Aluminum foil mounted on kraft, lead foil, greaseproof paper, glassine, pliofilm, vinylite, saran, polyethylene, and other similar materials—all of these are being used in making water vapor proof fibre drums. For certain products a combination of two barrier materials may be used together in the same drum, such as, aluminum foil and asphalt laminated kraft. One manufacturer uses a triplex barrier in the bottom of all heavy duty fibre drums regardless of the product to be packed—the triplex consisting of three sheets of kraft with two films of asphalt.

When any of the barrier materials are used as an inner ply to be exposed to the contents, such material is often referred to as the lining. If the barrier is only for water vapor protection, then it is a very common practice to place the barrier near one of the middle plies where it will not be harmed by abrasion. But when the purpose of the material is principally to prevent the penetration of the contents into the paperboard, then it is integrated with the inner ply and forms the inner surface of the drum.

Coatings may be used either on the exterior or the interior. These coatings may be applied by spray devices, or by other methods. Paints, lacquers, waxes, resins, and various plastics are used either for decorative purposes, product identification or for protection, or for a combination of these functions. Silicate of soda is often used as an interior treatment. Treatments may be applied by brush, sprays or dipping. Some treatments are actually coatings and others may be impregnations.

The words linings, coatings, and treatments are frequently used interchangeably and manufacturers use these terms according to their individual traditions or preferences. One very common treatment or coating is "free stripping," referred to in the section on "Fibre Drums for Hot-Poured Materials." The "Glossary of Packaging Terms" defines free stripping: "A term used to indicate a type of interior coating or lining which prevents solid contents from adhering to the interior of the drum." Paraffin impregnation is one of the most common types of treatment. To facilitate

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production of drums with some of the special linings, coatings, and treatments it is customary for the drum manufacturer to use drying ovens, light tunnels or other means of artificial drying.

Nesting

When one or more empty drums are enclosed within another for shipment or warehousing, all drums including the outer are classed by the trade as nested. Some of the freight tariffs use the term nested in a more restricted sense, requiring that the drums must be completely enclosed.

Nested drums may be of various capacities, such as, five gallon, ten gallon, and twenty gallon; or of the same capacity but different diameters. An example of this latter type as made by one manufacturer is the 41 gallon drum for 200 lbs. of powdered milk—a drum 20″ diameter by 30″ deep is placed inside of a drum 21½″ diameter and 26″ deep, with the 21½″ covers bundled separately. This economy in loading almost double the number of drums in a box car or motor—and in warehousing, has been an important factor in the introduction of fibre drums for a long list of products.

Loading and Handling Recommendations

Fibre drums should be stacked vertically—not on their sides. Many plants have barrel racks built for storing filled wood barrels on their sides. This avoids excessive drying and leakage around the headings and if the barrels contain liquids, they can be rotated easily at regular intervals to change the location of the void space. When fibre drums are introduced, the barrel racks should be removed so that the drums can be stacked vertically, either by lift trucks and pallets, or by manual labor.

Anyone interested in handling methods should write the Fibre Drum Manufacturers Association for their chart. Also a booklet on "Recommended Methods of Loading Large Straight Sided Fibreboard Drums" with 14 illustrations may be secured from the Association of American Railroads, Freight Loading and Container Section, 59 East Van Buren street, Chicago 5, Ill.

Moisture Protection—Insulation

The water vapor transmission rate in fibre drums can be controlled without much difficulty. Either separate bag liners may be employed as in barrels, or the barrier my be built-in as described previously.

In large capacity containers the water vapor transmission rate may be inconclusive as an index to product quality and condition. In 1949, the Forest Products Laboratory, Madison, Wis., conducted comprehensive tests with dried eggs in several types of containers and packaging. There were two types of fibre drums with built-in vapor barriers, wood barrels with special bag liners, No. 10 metal cans and several smaller units.

The contents of the drums and barrels weighed 170 to 175 lb. Tests required 112 days—three one-week intervals at zero and three 30-day intervals at 100° F and 90 per cent relative humidity. The gain in moisture content in the drums and barrels was slight and zero in the metal cans—but palatability losses were about equal!

This indicated that temperature and redistribution of moisture content within a bulk package may be just as serious as a small moisture increase from the otuside, whereas in small retail unit packaging redistribution within the package is a negligible factor.

The insulating properties of fibre drums are generally regarded as a favorable factor in product quality control. The temperature of an all-metal drum and its contents fluctuates rather quickly with environment temperature—such as, the changes from sun-to-shade and night-to-day. Technologists have observed that the fibre drum retards these fluctuations and holds them to a narrower range—an important consideration for many types of products.

How to Distinguish Fibre Drums from Other Bulk Containers

The two basic qualifications in determining whether a container is a fibre drum are—1) it must be cylindrical; and 2) it must be a shipping container.

Octagonal and hexagonal fibre boxes, either corrugated or solid fibre, are not fibre drums. They are not cylindrical and do not meet the minimum strength requirements in the freight regulations—Rule 41, Section 12.

Fibre drums differ from the cylindrical fibre containers commonly used for one-gallon or a half-gallon of ice cream and other foods, because the latter are used primarily for local truck deliveries and are not acceptable for general use when shipping by common carrier. Another important difference is that the ice cream containers are not built to meet the requirements in the fibre drum section of Rule 41.

General Comments

Most regulations require that every fibre drum must bear a "Certificate of Maker" stating the sidewall test in pounds per square inch; the net weight limit in pounds, and the maker's name and address.

Freight travels at the same rate in fibre drums as in barrels, unless otherwise provided in the tariff.

Fibre drums are lighter in tare weight than other rigid containers of comparable strength and capacity. Variations in construction and in the type and grade of container material make it difficult to give exact weights which would be generally applicable. However, as a typical example, the 41-gallon fibre drum weighs about six pounds less than a 24-gage steel drum, and from five to eight pounds less than a slack wood barrel. The weight differences in a carload are substantial. Another important characteristic of fibre drums is that the tare weight for any specification is uniform—so that labels, shipping stencil data, production records, and invoicing are all greatly simplified, in contrast with wood barrels where variations are greater and usually each one must be weighed, marked and individually recorded.

Fibre drums are generally "tailor made" for the product to be packed. Specifications are written not only to take care of the special characteristics of sensitive products, but sizes are selected to fit products of various densities, with a minimum of waste space. When wood or metal containers are used, the sizes available are few in number, such as, 5, 10, 20, 30, 40, and 55 gallons. Fibre drums are available in diameters from 8 to 23 inches and in *any* height from 3 to 42½ inches or greater.

Since depths in fractional inches may be specified, the amount of void space can be held to a minimum, which is generally desirable for hygroscopic products, and which also saves valuable space in warehouses, motor trucks, box cars and in cargo planes.

Fibre drums are used very largely for shipments between separate units of an industry, or between industries. Only a relatively small percentage is used for transportation to retail establishments, or to individual consumers. For many products shippers say there are no other satisfactory containers. Although no types of containers are indestructible, the excellent performance record of fibre drums has been a large factor in the growth of the industry.

The value of the contents of a single drum may be only two or three dollars—or several thousand dollars—yet deliveries are made safely to all parts of the world, and by any form of transportation.

Molded Pulp Products

W. E. Parsons

Keyes Fibre Co.

Since the molded pulp business has long been considered a poor relation of the paper business, and it has been the habit of paper manufacturers to look with a fishy eye upon the efforts of the molded pulp manufacturer, I think it fitting that a word be said about the beginning and the history of this youthful branch of the great paper industry.

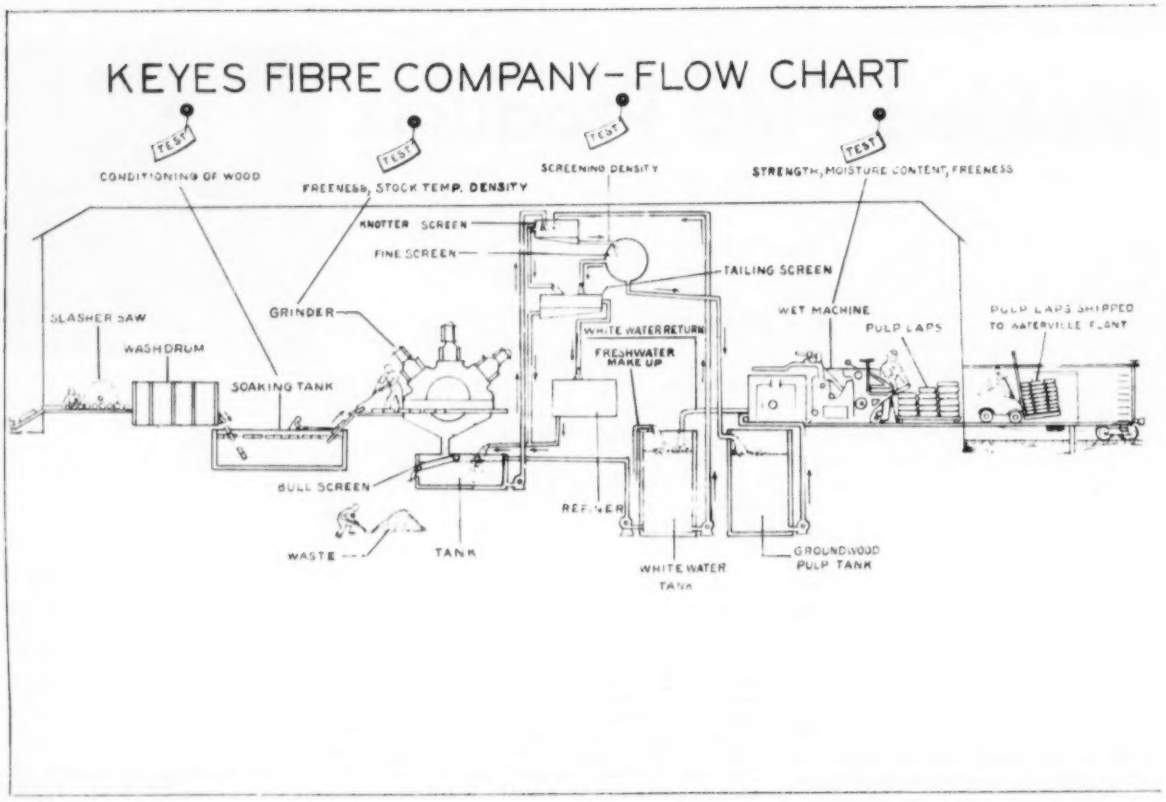
During the last quarter of the nineteenth century, there was produced a type of pulp article—not in a mold, but rather formed or pressed into shape—consisting of such common articles as washtubs, pails, cuspidors, etc. This particular pressed pulp business thrived for a time and then gradually disappeared as the more modern methods of shaping and forming metals appeared. While this particular type of pulp article was being produced in some quantity, there was a young mechanic named Martin L. Keyes working in a veneer plant in the Adirondack Mountains in northern New York.

The employees at this plant, who all came to work equipped with dinner pails, would at the noon hour take small pieces of veneer and use these pieces for plates. Keyes long observed this habit and, having an inventive mind, he visualized the molding of a piece of pulp into the shape of a plate without the disadvantages attendant to forcing flat sheets into that shape. For some years he turned this over in his mind and finally approached what is now the Union Bag & Pauer Co. with his idea. They showed a slight interest and did some experimental work on the project. So obsessed was he with the possibility of this idea, that he finally gave up his job as a mechanic and went to the State of Maine, where he had friends in the lumber business. These friends provided him with sufficient funds to build a pilot machine embodying his molding idea. After several failures, he finally came up with a piece of apparatus that would actually mold a plate from a furnish similar to that used in the manufacture of paper. The result of this successful effort was that his friendly lumber people put up sufficient money for him to build a small plant with two molding machines. This was accomplished in 1903 and was the beginning of the molded pulp business as a commercial enterprise.

Wallace Emory Parsons, a native of North Anson, Maine, studied at Hebron Academy and at the University of Maine. After service with the United States Geological Survey, Orono Pulp and Paper Co., Moulton Engineering Corp., Cumberland Ship Building Co., and the Fairfield Manufacturing Co., he joined Keyes Fibre Co. in 1926 as assistant to the president, was general manager from 1928 to 1951, vice-president and director from 1942 to 1951 in which year he was elected president of the company. In addition to his activities for Keyes Fibre Co. he is a director of the National Assn. of Manufacturers and a Vice-President and Director of the Assoc. Industries of Me.

The molded pulp production for some years thereafter consisted simply of pulp pie plates, which were gradually adopted by the baking trade as a transfer or delivery plate. Unfortunately, Mr. Keyes, who was the pioneer in this field, died in 1914 and his heirs were satisfied to operate the substantial plant which he then owned strictly on the manufacture of pie plates. This plant was the Keyes Fibre Co. and, since 1908, had been located in Waterville, Maine. The business was considered a simple one, although subsequent events proved the facts to be far different. The dies were built by good machinists, but without particular care as to detail, and the question of the furnish to be used in the manufacture of these plates was left largely to the ability of the plant management to obtain groundwood pulp which they could mold. Why they could mold it, or what specifications might have been established to improve its molding qualities, was given little thought. The Keyes plant operated successfully and profitably on the limited line that they were producing until 1927, when that company fell into other hands. Incidentally, I might say that this was the year that I joined the Keyes Fibre Co. The present management found it had acquired a unique business which had been operating, protected by patents, on a financially profitable basis for at least twenty years.

Among the earliest patents issued on automatic pulp molding machines for the manufacture of pie plates and the like were those issued to Martin L. Keyes. His first patent for such a machine was applied for in 1901 and issued in 1903. This patent, together with subsequent patents issued to Mr. Keyes, was sufficiently broad and fundamental to enable his company to practically dominate the molded pulp plate market until sometime in the 1920's when his basic patents began to expire. Since that time, the Keyes company has developed improved molding machines of various types and the other companies entering the industry have developed their machines, which accomplish in a general way the same end. At the present time the molded pulp art is considered a crowded one in the United States Patent Office. While all of this modern equipment is fundamentally designed on the princi-



ples originally invented by Mr. Keyes, it is, however, much more advanced in design and capable of manufacturing a product of better quality and in large volume than was possible on the original Keyes machines.

In 1927 there was not a single engineer or research man on the payroll. Molded pulp plates competed only with pressed plates, and Keyes Fibre Co. made all of the molded pulp plates produced. As the patents began to expire, several other manufacturers began to look at molded pulp with interest, and it was only a matter of time when they began in a very small way to produce similar articles to those which Keyes only had been producing prior to 1927. With a competitive situation established, the question of quality and manufacturing costs became extremely important, and the result was a development in this industry, on the part of all of those engaged in it, of research and engineering forces similar to those which were making the great progress possible that was being enjoyed in the paper industry as a whole.

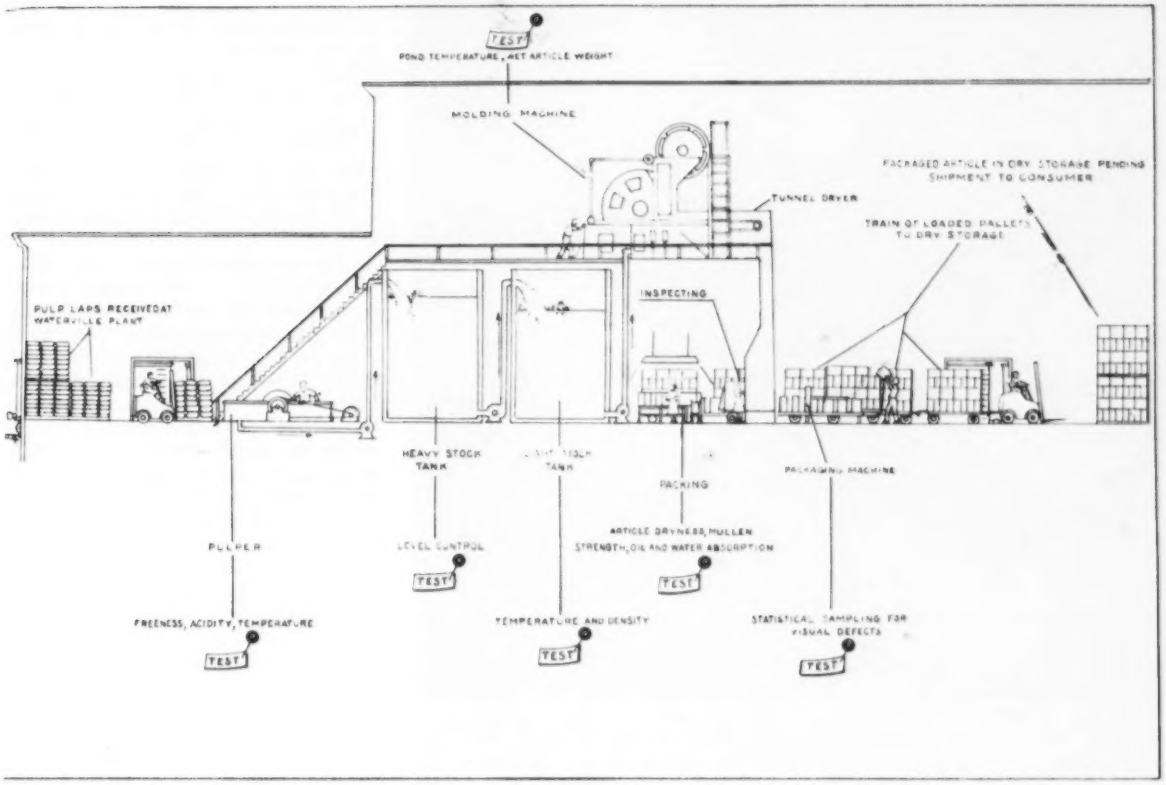
The molded pulp lines have been expanded and adaptability to many other uses proven in the past twenty-five years. There are at the present time a half-dozen companies in the United States engaged in this business. Where in the beginning the business was based entirely on the production of pie plates for use by the bakers, molded pulp was later found to be adaptable for many purposes—picnic plates and articles for household use, egg flats for bulk packing of eggs, egg cartons for individual sales, interior packing for many fragile articles including such items as fluorescent tubes and other glassware. It has also reached into the fruit packing field, and the finest apples in America are now packed in flats, each apple on its own pocket. A typical example of the unusual use of molded pulp is in the manufacture of cores for plywood doors. All flush plywood doors have to have a filling of some sort between the frames, and it has lately been proven that the least expensive and one of the most satisfactory cores for doors of this type is the molded pulp article. There are other uses too numerous to mention which are growing steadily, all of which indicate that this healthy young relation of the paper business will be heard from more and more as time goes on.

To approach logically the subject I shall attempt to outline the procedure from furnish to finished article.

Types and Characteristics of Pulp Used

It goes without saying that for food service purity is the first must, so articles for the handling of food are manufactured usually from strictly virgin pulps. Groundwood is the primary pulp and is used by itself or in combination with other chemical pulp, such as bleached or unbleached sulphite or kraft. The chemically cooked hardwood pulps make excellent pulp molding fibers and are used sometimes by themselves for certain high grade articles. These hardwood pulps must be developed by straight hydration to an approximate freeness of 300 Canadian Standard. Groundwoods for pulp molding are generally somewhat freer than those commonly used in papers. Freeness will vary from 150 to 300, depending upon the particular type of molding equipment being utilized.

For packaging materials, waste fibers such as old news, corrugated cuttings, envelope scrap and other grades can be utilized. In this type of furnish usually groundwood or old news is the major source of fiber, being balanced by any of the other waste materials to any percentage that is necessary to maintain the properties required and make the furnish as economical as possible. Shrinkage is the prime enemy of the pulp molding process, so a rigid control of waste materials is essential to eliminate any highly developed pulps which would be unmoldable due to high shrinkage.



Blends of waste papers are prepared to have a combined freeness of from 170 to 300 in order to maintain proper and high speed machine operation.

Water and Grease Proofing

The most common water and grease proofing agents are, as in the paper industry, rosin and wax. Rosin is used where water resistance is needed and is especially effective against the absorption of hot, watery liquids. Wax is used primarily to size against the penetration of vegetable oils. The melting point of the wax used is a function of the degree of hot oil resistance. At present 164°F melting point wax is the highest on the market of the straight crystalline paraffin type. Due to the vegetable oil solubility of the microcrystalline type, their use is somewhat limited in this field.

Miscellaneous Ingredients Such as Mold Preventatives

Starch is sometimes used in a furnish to increase stiffness and to give smoother surfaces to die dried articles. Some modified types of starch can be used to bolster rosin or wax effectiveness. Wet strength resins, both melamine and phenolic, are added to furnishes where an article, usually for packaging, would be in danger of getting wet or be stored at high humidities such as in cold storage. With these wet strength resins it is possible for a molded pulp article to retain wet 40-50 per cent of its original dry strength. There are various mold preventatives, such as Nalco or Dowicide for example, that are sometimes added to a furnish in small quantities to prevent or retard any mold growth due to long residence in humid atmospheres. Typical of this application is the egg packing material, where articles may be held for long periods in cold storage.

Description of Testing Processes Used in Quality Control

The four major phases of control in the manufacture of molded pulp are:

1—Raw material testing
2—Process control
3—Finished article testing
4—Statistical sampling of finished articles

All pulps are tested for moisture, mullen and dirt count. In most cases standard hand sheets are made on the raw or undeveloped pulp. In some cases chemical pulps are developed to varying degrees to indicate the proper development needed to give the strengthening properties specified in special furnishes. The testing of pulps of all characteristics are by the standard TAPPI methods. The limited chemicals used, such as rosin, wax and alum, are checked periodically, as the uniformity of these products is well established by the producing companies.

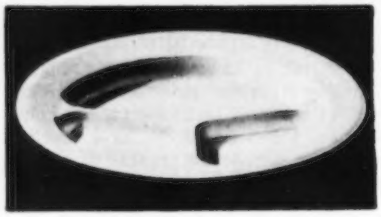
Process control consists mainly in making regular tests while the articles are being manufactured to assist the operators in maintaining the proper quality. Typical of these process tests are beater and pond pH, pond densities and temperatures, wet end weights and drynesses, dry end weights and drynesses, and careful inspection of the slurry or the product being manufactured, whereby any irregularity in the process can be spotted as soon as possible.

Finished articles are checked as they come off the machines and tested for the specifications that have been previously established for whatever grade of article is being manufactured. These tests are generally weight, sizing, moisture content, mullen, tensile and stiffness. Sizing tests are run by placing water or oil in an article (particularly plates and dishes) up to a depth of ¼ inch. Depending upon the degree of sizing required, water temperature is varied from 80° F. to boiling and oil temperatures from 80° F. to 300° F. Vegetable oils only are used for these tests. Another sizing test utilized for slack to medium sized articles is moisture absorption. Here the article is

Food trays for pre-packaging foods.

conditioned, then immersed in water for a period of twenty minutes, after which it is removed, shaken to remove the loose water, and weighed. The water pickup is calculated and reported as moisture absorption in percent. Penetration tests where the oil or water is placed in the article are reported as the number of minutes required to penetrate the article so that it can be seen on the bottom or opposite side. Twenty minutes is the usual control duration of the test, and if no penetration has shown the test is reported as satisfactory. Physical tests taken, such as mullen, tensile and stiffness, vary depending upon the article. Tensile is important on many packaging articles, while mullen and stiffness might or might not be. Often the design of an article is such that the tensile and stiffness tests are impossible due to the lack of flat areas. On plates and food containers mullen and stiffness are important while tensile is not an end use factor.

The Dodge & Romig sampling inspection tables are used for inspection of all articles prior to leaving the mill. Our acceptable quality level is .65 to 1.2 per cent defective articles. With the above acceptable quality level tests we can guarantee our customers that less than 1.2 per cent defective articles leave the mill. In the Keyes plant, using the above sampling plan, our process average for defects being shipped is .20 per cent, well below our acceptable quality level.



Single service table plates.

Manufacturing Specifications

All pulp molded articles should be manufactured to certain and definite specifications. The first consideration to be given is a proper and most economical furnish. When this is definitely established, a standard furnish is issued to the manufacturing department, who within reasonable limits are expected to adhere to it very closely. Specifications are also given for minimum physical properties, such as mullen, tensile and stiffness. Also minimum sizing specifications are included, such as water absorption or peneration. It is also the general practice to establish specifications for dryness to insure proper but not excessive drying. Such specifications as above described cover in general what is usually definitely set up for production purposes. There are, of course, special articles for certain end uses, where it is necessary to make other tests to meet these specifications. Usually, however, these requirements are more or less established from the use requirements of the article and vary greatly as these requirements vary. As an illustration, if a packaging material must have structural strength, here a compression specification is added. A control laboratory should be operated, in conjunction with research and engineering, which at regular intervals evaluates all articles and checks them very carefully to make sure that the specifications set up are covered adequately in the final quality.

Stock Preparation Equipment

Generally speaking, the stock preparation equipment in a pulp molding plant is very similar to that used in board mills and other operations where specialties are produced using a furnish that is chiefly groundwood pulp. This is true whether the raw material be virgin pulp or the pulp described above made up from waste materials. This equipment primarily consists of breaker type beaters or pulpers, which serve to defiber the pulp. In the case of virgin pulp it is usually received in wet laps or dry bales, and in bundles or bales in the case of waste paper. There are, of course, numerous types of pulping equipment available for this purpose. The conventional beating engine, Hydrapulpers, Dynapulpers, Liebecks, or any good pulping engine are generally satisfactory for the purpose. The selection of a particular type of equipment to be used is generally influenced by the type of raw material to be pulped and by the space available for its installation. In addition to the beating equipment, in many instances jordans are added where particular refinement of stock is required.

Molding Machines

There are several types of accepted molding machine, but it should be

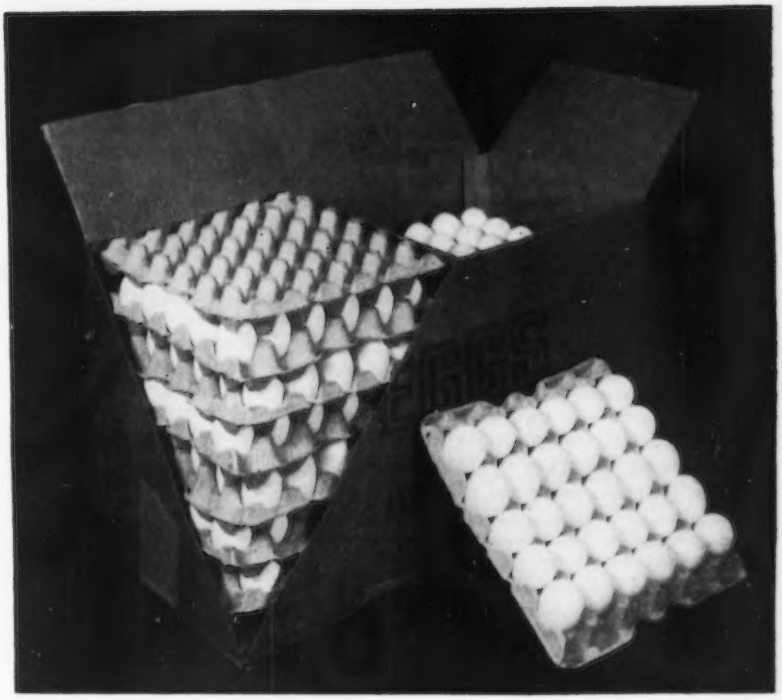
Baker's cake circles.

pointed out that currently there is no universal machine in the general market. The situation in the several molded pulp mills now operating in the United States is unique. The machines in each one of these plants have been developed by those particular companies and, while the basic principles employed are the same, each company has its own especially built molding equipment. Fundamentally, an automatic pulp molding machine used in the manufacture of molded pulp articles, such as plates, dishes, etc., is a machine which carries one or more forming dies, each having a porous face of the shape of the desired article. These dies are rotated or reciprocated through a pond of dilute pulp stock, during which process by means of suction a layer of fiber is deposited on the shaped face of the die. After this die leaves the pulp stock, there is a short interval of time which allows for the suction drainage of free water from the deposited sheet of pulp. The formed article is then usually compressed between this forming die and a complemental die. It is then removed from the forming die by this complemental or pressing die and then transferred by some means to a dryer conveyor or further sets of drying dies.

Broadly speaking, there are at present two types of molding machines most generally used in the manufacture of molded pulp articles. One type molds the product and transfers it in a wet state to a tunnel type dryer for the complete drying of the article. The second type molds the article and transfers it to a set of complemental heated drying dies, between which the article is dried under heat and pressure. The first type of machine with its dryer produces what is known in the molded pulp trade as rough finished articles and is used in the manufacture of such products as pie plates, egg flats, cartons and many other items used for the handling of fragile articles, or for purposes where the rough surface appearance is satisfactory. The second type of machine mentioned above manufactures a product which has a calendered finish on at least one side. It is of much better appearance and, for use as a picnic plate, or where the resultant product is to be printed, for example, is much more suitable than the rough type of product.

Drying Methods

Dryers of the tunnel type are used for drying by far the greater percentage of molded pulp products. Such dryers are usually constructed of an insulated steel shell through which run one or more conveyor belts, generally of some woven wire type, which carry the product to be dried. Heated air is circulated through the dryer by means of fans or blowers in the manner which will give the most efficient drying. This air may be heated to the required degee by any suitable medium such as steam, oil fired heaters or natural gas. Dryers of this type, in both size and rated capacity, are generally designed to match the production pattern and capacity of the molding unit to which it is connected.



Egg shipping trays.

Direct die drying, as mentioned above, to meet the demand for a plate or dish which has a calendered finish, at least on one side, and which is of uniform shape and free from warpage, is the accepted method for certain purposes. In this case it is necessary to dry the molded article between the complemental dies under heat and pressure sufficient to produce a smooth finished face side on the article. These articles are generally referred to in the trade as the smooth finished articles to distinguish them from the tunnel dried article. These drying dies are generally electrically heated, and one of each set of complemental dies is a perforated die covered with a woven wire gauze to permit vacuum exhaustion of the steam vapors from the drying article. The other or face die has a highly polished surface which imparts a smooth finish to the contacted side of the article. The wet articles molded on forming dies are automatically transferred to one of these complemental drying dies, usually the drainage die or the one which is perforated, after which the two dies are closed together under heat and pressure for a sufficient time to completely dry the product. After drying, the dies are parted and the dried product is automatically removed from the drying die and ejected from the machine.

There is still a third molding process which has met with some favor and has been employed to a limited degree. This process is similar to the process for manufacturing smooth finished articles, except that it adds the application of a lining coat to make plate surfaces, for example. The process is very similar to the one above described employed in the production of smooth finished articles, but the machine is elaborated to produce a liner of higher grade which is applied in the automatic operation to the face of the article before the drying cycle begins. Its operation beyond that point is almost identical with the smooth finish process previously described.

After-Pressing Equipment

There is an after-pressing process which has been introduced during the past several years, developed primarily for the purpose of removing objectionable warpage and to restore accuracy to contour. This process also permits

the improvement of the surface finish of rough finished articles such as high grade egg cartons so that they have a calendered surface and take printing in an excellent fashion. The equipment consists of automatic presses equipped with polished steel pressing dies of the same shape and contour as the dried articles. These dies may be steam or electrically heated. As the rough finished dried article emerges from the tunnel dryer, it is automatically fed into the presses, where it is pressed for a very short interval under heat and relatively high pressure. It is then ejected to conveyors which feed the printing presses if printing is required. The article is then automatically counted and stacked at the end of the printing presses. This process results in improved finish and general appearance while still maintaining the resilient cushioning qualities of a rough finish product which are so desirable in the packing and protection of fragile articles.

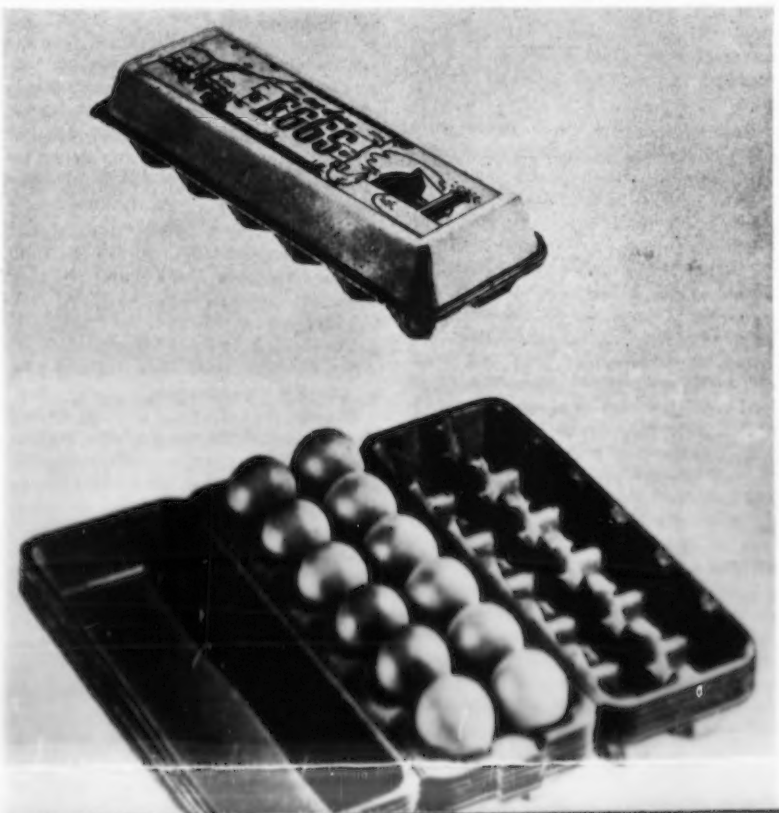
Stacking and Handling

It is unnecessary to say that the handling at high speed of large numbers of comparatively light articles, such as most molded pulp products are, presents a serious problem. In the original installations in this field these articles were stacked by women as they came from the end of the dryer or were ejected from the smooth finish machines. With constantly increasing labor costs, however, this became a very expensive operation, and much study has gone into the problem of automatic stacking and packing during the last few years. In my own company we are automatically stacking a considerable percentage of our products and we are fast developing further techniques which indicate that it is only a matter of time when practically all molded pulp articles, at least those of anywhere near uniform shape, will be automatically stacked.

In the case of plates, dishes, and most small articles, it is customary to pack for the trade in fiber cases. There are, however, many molded pulp articles, such as egg packing material and heavy packing units, which are either wrapped in paper or are simply tied with string. It is customary in most plants to handle this material on pallets with lift trucks. In our own plant, for example, [illegible] we handle nothing that is not so put up. An interesting point in connection with the molded pulp industry, it is an interesting subject and worthy of attention from anyone handling a large number of units of varying size and type.

Before closing, it seems to me that a word should be said about the world wide growth of this particular business. As I have previously pointed out, the entire molded pulp business, as it is now operated, has grown up in the last fifty years. Its expansion out of the pie plate field did not begin to take place until approximately 1930. Since then, there have been molded pulp plants built in Canada, Northern Ireland, England, Norway, Denmark, Holland and Australia. Most of these were built primarily for the manufacture of egg packing material, but they have gradually broadened their bases until several of them are making a line of molded pulp articles.

This presents in a general way the picture of the molded pulp process. There is still much detail that could be filled in, and I hope that the rather brief descriptions I have given you will not lead you to think the process is too simple to be interesting. At times it is more than interesting; it is very complicated. If I were to indicate in a few words the difference between the average sheet of paper and a piece of molded pulp, I think I would go back to the difference between woolen and worsted—two cloths with which we are all quite familiar, although I find few of us know the difference. In a piece of woolen cloth the same material may be used as in the other type but the combing process is much different. The fibers are not laid parallel in a piece of woolen. In the case of worsted, while the material may be the same, the combing process is so designed as to lay parallel all of the fibers. This is the difference between the two cloths. Simply then, shall we say that molded pulp is the woolen and fine paper the worsted. While it is doubtful if any of you here tonight will be engaged in the molded pulp business, there is always that possibility. Should this be your lot, I trust that in some small measure the above description of the process may be of assistance to you.



Multiwall Bags

George N. Burns

Chase Bag Co.

Probably no subject at first glance presents a more uninspirational aspect than a description of the romance of the paper bag. Somehow it is difficult to lend a romantic flavor to a container for bulk materials which, in themselves, are pretty undramatic items. Yet the obvious necessity for a cheap but adequate means of carrying and storing more than six hundred materials which go into production of necessities for war as well as for our everyday life calls for serious consideration. The paper shipping sack industry is a vital force in the packaging field. There is hardly a product you eat, wear, or use that at some stage in processing has not traveled in paper bags. Multiwall bags constitute about 60 per cent of the total bag industry volume, including cotton and burlap shipping sacks.

This discussion by its very nature must be delivered along unacademic lines with no attempt at formality. I hope it will present to you an insight on a segment of the sixth largest industry in the United States, a few of its problems and its ambitions to serve better almost every type of business in one form or another. The major part of this talk will be concerned with outlining briefly the details of the subject and a period is reserved for questions and answers.

It is not definitely known just when paper bags were first made by hand or first introduced into this country but it is disclosed that the earliest patent for a machine to manufacture single wall paper bags was granted in 1852. It was not until the turn of the century that there were rapid developments in the paper bag industry—developments which finally led to the multiwall shipping

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barrels, boxes, and some textile bags were the common carriers of such products, with the accompanying initial high cost per item, in addition to tare expense an lack of sanitation. Flour, for example, was packed in a wooden barrel of 196 lbs., following the English stone weight. With a container such as this, standing in a shed or corner of a crossroads grocery store, it's not hard to picture the dirt and infestation which resulted in a housewife's package. Cement, for the many requirements of a growing country, was shipped in a barrel of 376 lbs., or 4 cubic feet. This rigid, unwieldly container was subject to easy breakage and its cylindrical proportions consumed valuable storage space.

Gradually, cotton and burlap bags took over much of the rigid container business in [illegible]

cipal kind of container for bulk materials until shortly after World War I. Pasted open mouth paper bags of the one and two wall variety had been manufactured for some time but were not considered seriously as an industrial package on a large scale. These containers were usually closed by string or wire ties and constructed of a wrapping or grocery bag variety of kraft.

Custom Made

Multiwall paper shipping sacks are custom-made. They are not, for practical reasons, manufactured and stored in stock types and sizes because each product packaged has its own requirements. With certain very minor exceptions, each multiwall bag made is designed and built with a specific packaging job in mind. During the period between World Wars I and II, multiwall bags became gradually recognized and accepted by a wide variety of consumers.

In the food products industry, it became demonstrable that paper bags, since they were one-trip containers, combined economy with sanitation. Flour mills found them better protection against weevil and vermin which normally infest returnable textile bags. The absence of sifting, typical of textile bags, and the ease of dumping the contents from a smooth paper bag appealed to the consumers. In the building industry such materials as cement, lime, and plaster maintained their original condition far better under shipping and storage conditions in multiwalls than in cotton containers. Contractors eliminated the nuisance of returning empty cotton bags, faulty bag counts, and arguments over [illegible]

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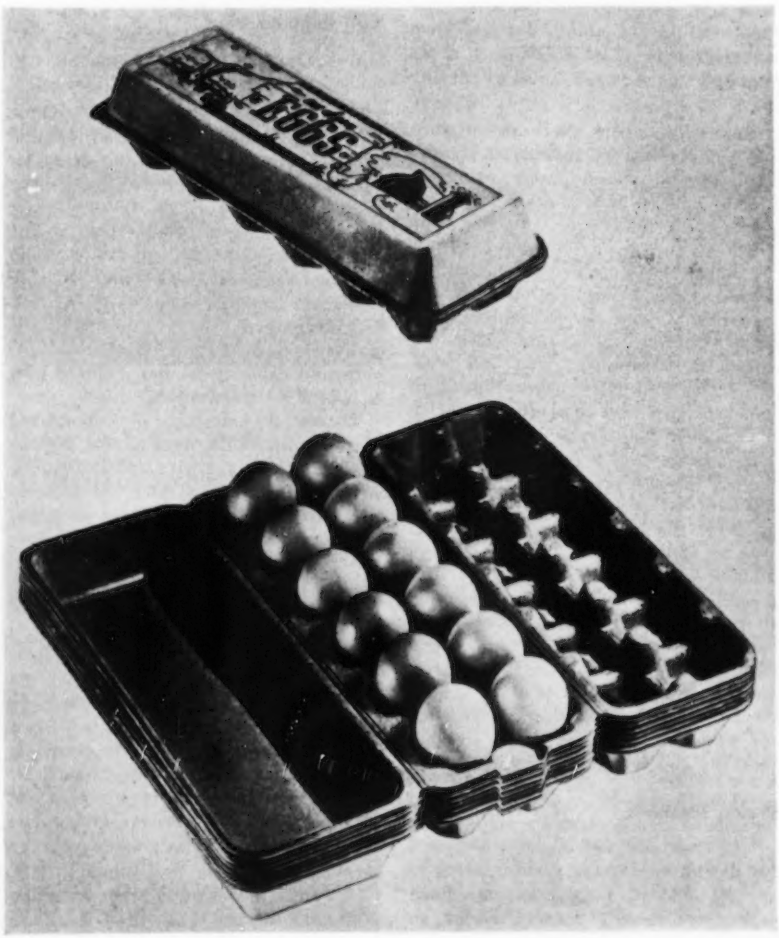

Molded pulp egg cartons.

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Storage and transportation problems have grown increasingly complex as our country expanded, particularly in regard to food materials and building supplies. In the 19th century wooden barrels, boxes, and some textile bags were the common carriers of such products, with the accompanying initial high cost per item, in addition to tare expense an lack of sanitation. Flour, for example, was packed in a wooden barrel of 196 lbs., following the English stone weight. With a container such as this, standing in a shed or corner of a crossroads grocery store, it's not hard to picture the dirt and infestation which resulted in a housewife's package. Cement, for the many requirements of a growing country, was shipped in a barrel of 376 lbs., or 4 cubic feet. This rigid, unwieldly container was subject to easy breakage and its cylindrical proportions consumed valuable storage space.

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Illustrations in this article are reproduced through the courtesy of the American Shipping Sack Manufacturers Association, Inc., from the Association's General Manual No. 3.

Custom Made

Multiwall paper shipping sacks are custom-made. They are not, for practical reasons, manufactured and stored in stock types and sizes because each product packaged has its own requirements. With certain very minor exceptions, each multiwall bag made is designed and built with a specific packaging job in mind. During the period between World Wars I and II, multiwall bags became gradually recognized and accepted by a wide variety of consumers.

In the food products industry, it became demonstrable that paper bags, since they were one-trip containers, combined economy with sanitation. Flour mills found them better protection against weevil and vermin which normally infest returnable textile bags. The absence of sifting, typical of textile bags, and the ease of dumping the contents from a smooth paper bag appealed to the consumers. In the building industry such materials as cement, lime, and plaster maintained their original condition far better under shipping and storage conditions in multiwalls than in cotton containers. Contractors eliminated the nuisance of returning empty cotton bags, faulty bag counts, and arguments over damaged sacks.

A wide variety of chemicals, which were formerly packed in drums and boxes, have found multiwalls a very satisfactory container. The largest individual consumer in this category is the chemical fertilizer industry. The

basic ingredients forming this essential material are nitrate, phosphate, and potash. When fertilizer is used it must be in a free-flowing condition to allow distribution through drilling equipment. If the soil's deficiency requires a fertilizer of high acid content a container must be used which will prevent the material from "setting up", and which will not deteriorate from the chemical action of the contents. Paper bags constructed with an especially treated sheet next to the material perform these functions well. They even allow the farmer to distribute his filled bags at the ends of his rows and leave them without fear of moisture absorption during mild rain storms. The above illustration could be developed regarding many other chemicals whose peculiar make-up calls for special types of paper bags to suit conditions. These extras may add some small additional costs but still place multiwall bags in the most favorable position economically speaking.

Special Applications

Multiwall bags constructed either of straight kraft or with one or two walls of special paper, offer far better protection to hydroscopic, deliquescent or high acid materials than do textile bags. Hygroscopic means the ability to readily absorb and retain moisture, including that from the atmosphere. Samples of hygroscopic materials are cement, powdered milk and powdered sugar. Deliquescent means to dissolve gradually and become liquid by attracting and absorbing moisture from the atmosphere. Calcium chloride is a deliquescent material which is being satisfactorily packaged in multiwall paper bags. An example of high acid material is fertilizer which contains sulphuric acid.

Since the cement, fertilizer, sugar, and flour industries are the largest consumers of multiwall bags, the most economical package which will do the optimum job is paramount in importance. Also, the high costs of cotton sheeting and baled burlap have sped the growth of the multiwall industry since the beginning of the Korean War far faster than normal expectations.

It has been said that the industry which received the greatest single impetus by the emergency conditions of World War II was the manufacture of paper bags. Textiles were in great demand for many purposes other than containers and such goods were allocated. Many packers who considered all paper bags in the same category as the grocery bag, whose bottom is likely to rupture with slight pressure, were forced by circumstances to pack in multiwalls. To their delighted surprise they "discovered" a package both light and cheap which transported and stored their products better in many instances than the textile container. In consequence, the industry has grown from a production of a few hundred million units prior to 1942, to about 2½ billion in 1951.

The more progressive manufacturers maintain laboratories and machine shops where the adaptability of newly developed sheets for paper bags is explored and improved methods of manufacture to yield better bags are developed.

Construction

Multiwall bags, as the name implies, are constructed of three to six walls, one nested within the other in such a way that each ply takes up its share of the burden. A type of specification kraft known as "cement sack grade" makes up the majority of multiwall bags. Most paper mills furnishing this type of kraft attempt to meet the Federal Standard Stock Catalog Specification UUS-48-b. Actually this Government requirement was put together to eliminate the manufacture of heavy-duty bags from grocery or wrapping paper stock for Government purposes.

Basis weights (24 x 36", 500 count) usually incorporated in a bag, run from a 40-lb. minimum to a 60-lb. maximum. While the Freight Classification regulations exert control of the minimum constructions of each bag for certain weights of particular materials, the practice and experience of the individual manufacturers usually dictates the make-up of a particular container which is to be designed for a specific purpose.

Some materials contain a high percentage of moisture and require an asphalt impregnated sheet or an asphalt laminated wall next to the material to prevent the dampness from weakening the remaining walls. Other products attract moisture and require these special sheets or others for moisture vapor barriers. Again, bags containing high acid materials require special protective sheets so the natural kraft walls may not be attacked. Cellophane, glassine, waxed, and Polyehylene papers have been used to a much lesser degree for protective purposes. Generally a multiwall bag of all natural kraft construction affords so much more protection from external dampness and sifting compared to textile containers that special sheets in most instances are unnecessary. Wet strength sheets are used to combat moisture when packaging potatoes.

Still on the subject of construction, it is essential for good performance that the rolls of paper as well as finished bags be stored under controlled atmospheric conditions. When the inate moisture in kraft paper falls below 6 or 7%, you are aware that the sheet becomes brittle and loses normal strength. A similar unfortunate condition results when paper or bags are stored in sub-zero warehouses Happily, kraft can be restored to a condition of optimum performance if exposed to the proper atmosphere. Bag manufacturers try to educate their customers on this important variable, with increasing success. Large users who carry sizable inventories of paper bags normally store in conditioned rooms. Chase has prepared a folder on proper storage and I have a copy for each of you.

A few years ago there was some prejudice against southern kraft as compared to northern. There was an erroneous impression that fast-growing lobolly and jack pine could not be treated sufficiently in the digesters to remove the high resin content which would render the fibers more brittle and result in a paper of low tensile strength and tear resistance. This theory has ben exploded by practice and is supported by the Federal Standard Stock Catalog requirements, which make no qualifying specifications between northern and southern kraft.

Seven Bags

Multiwall bags are of two general types—sewn and pasted. Each type is subdivided into open mouth hand valve bags.

A sewn open mouth multiwall bag is composed of three to six walls. This type of container is three dimensional, unlike most pasted bags. It has a specification for face width, gusset width, and tube length. The walls are formed by suspending the same number of rolls of paper as the bag requires walls on the rear of a tuber machine. Prior to setting up the roll forming the outside ply, that paper is usually printed in much the same fashion as a newspaper. Naturally, the width of the roll must conform to the bag width required. For example, a bag 19 x 3½ x 37¾" calls for a 46" paper which is concluded by adding face and gusset, multiplying by two, and adding 1" for the overlap of the longitudinal seam. The tuber is adjustable to make a variety of tube widths and the better pieces of eqûipment are sufficiently versatile to accomodate the majority of sizes required commercially. As the paper answers to a steady pull from the draw rolls, it is constricted between formers to the required width dimensions, and at the same time small wheels indent the tubes laterally and form gussets or sides. After this process, a cylinder containing a serated blade contacts the

1—THE SEWN, GUSSETED, VALVE TYPE SACK is completely fabricated in the bag factory. There is a small opening or valve in one corner through which the sack is filled. The valve is made with an inner flap which operates as a self-closing check valve as soon as the sack has been filled. This sack is made with a plain valve or a valve with an extended inner sleeve.

2—THE SEWN, GUSSETED, VALVE TYPE SACK WITH OUTER SLEEVE (TUCK-IN SLEEVE). After the sack is filled, sleeve is folded manually, down and back into the pocket under the sleeve, making a securely held positive closure against sifting. (Note section 2 for methods of positive sleeve closures.)

All valve type sacks are used with automatic valve filling equipment.

Sewn Valve Type Sacks (1) and (2) are occasionally made of flat tubes, non-gusseted.

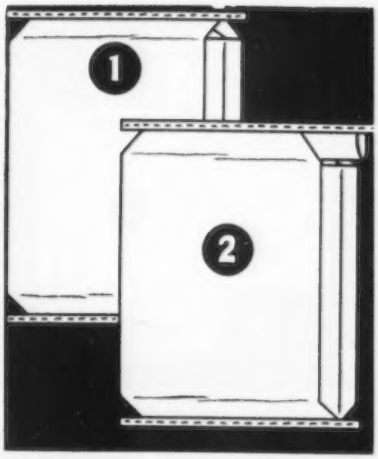
3—THE SEWN BOTTOM, GUSSETED, OPEN MOUTH TYPE SACK. Bottom closure is made in the bag factory. After the sack is filled, top closure is usually made by sewing. Wire tying, stapling, gluing or gummed tape are less frequently used. Automatic and semi-automatic filling and weighing machines are available which apply bound-over tape either before or after sewing.

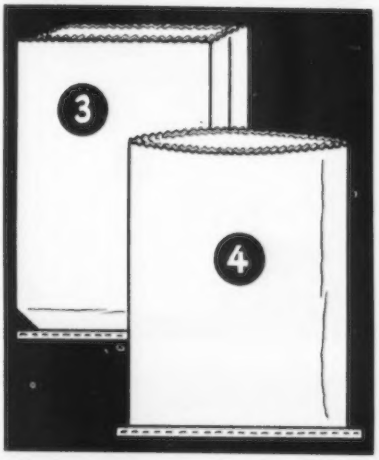
4—THE SEWN BOTTOM, FLAT TUBE, OPEN MOUTH TYPE SACK. Bottom closure is made in the bag factory. After the sack is filled, top closure is made by sewing.

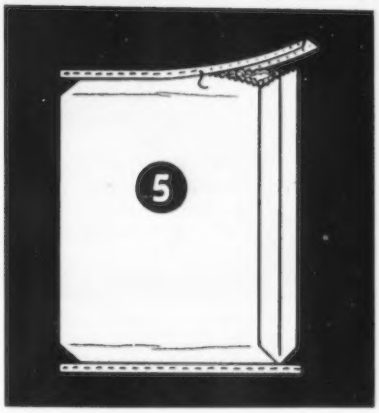
Top closures of sewn bottom open mouth sacks should be made equally as strong and sift proof as factory made bottom closures.

Sewn closures, sealed (dipped ends). In multi-wall packaging of some types of sensitive products, or where products are exposed to extremely hazardous climatic conditions, taped, sewn closures are dipped in a sealing compound. The sealing compound is absorbed by the tape, thread and filler cord making a moisture-tight flexible closure.

5—THE SEWN BOTTOM, SEWN TOP, OPEN CORNER SACK. This is an intermediate variety between the valve type and open mouth type sack.







These sacks are often used for commodities which are liquid when poured hot, and which solidify into a block which takes the shape and size of the sack when cool.

Filling is usually done by a pipe inserted in the open corner. The plies at the open corner are then brought together and stapled and the tape stapled down over this closure for fur further reinforcement.

tube and cuts it off to the required length. When the outer roll is printed, impressions are made at the desirable division point so that electric eye impulses actuate the cutting knife. Dependent upon the number of plies, basis weight, and the inclusion of a special sheet or sheets a well regulated tuber will produce 5,000 to 12,000 units per hour. For example, a cement bag tube 15½ x 3 x 26½", constructed of 2/40 and 2/50 can be produced at the rate of 12,000 per hour.

Tubes are carried to the sewing tables where the bottoms are secured with 2⅛" 90 lb. crepe tape. Stitches are made no more than 3½ to the inch, with both needle and looper threads in addition to a filler cord. This latter is of either paper or cotton, and its purpose is to prevent the sifting of fine materials, presents a partial barrier to air-borne moisture, and to cushion the stitches against cutting the paper. Open mouth bags are usually closed by wire ties or sewing, with or without tape, at the customers' plants after the bags have been filled.

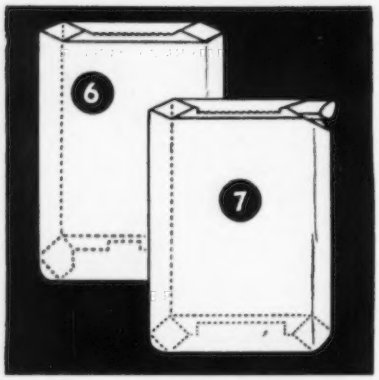
Valve Bags

Sewn valve bags are manufactured in about the same way as the sewn open mouth up to a point. A valve bag carries the somewhat perplexing title of a "pre-closed" container. The valve is actually an orifice created by an instrument with a finger-like device which indents one corner of the tube and leaves an opening for the insertion of a filling tube on an automatic packer at the customer's plant. The subject of mechanical packers is too complex to include in this lecture, but it might be informative to mention in passing that they vastly reduce packing costs. A cement packer may have four outlets on one unit operated by one man. As the bags are discharged automatically the operator is engaged soley in attaching the bags to the filling tubes.

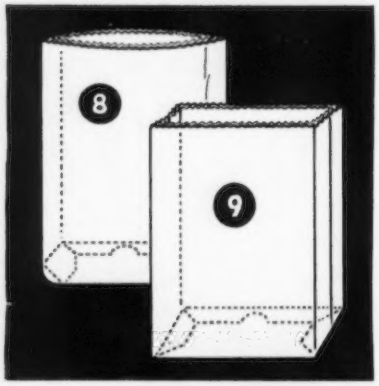
After the tubes are formed they go through the valver before sewing. At this manufacturing point a bag may be a simple valve bag, or one with special sleeves. The principal of valve bags is to save labor costs in closing the bag after filling, and maintain reasonably accurate weights. The pressure of the material against the valve when the bag is in a horizontal position quite effectively seals this aperture. In the case of very fine, free-flowing materials, those which have an affinity for moisture and are likely to become infested, certain types of valve sleeves are required.

The tuck-in sleeve, made of 90 lb. basis weight creped paper, which is cuffed around the inner side of the valve to make a complete seal, extends

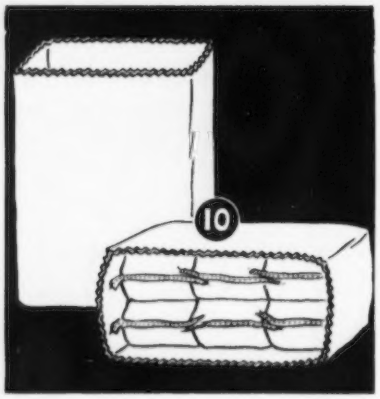
6—THE PASTED VALVE TYPE SACK is completely fabricated in the bag factory. There is a small opening or valve in one corner through which the sack is filled by automatic valve packing equipment. The valve is made with an inner flap which operates as a self-closing check valve as soon as the sack has been filled. This sack is made with a plain valve or a valve with an extended inner sleeve.



7—THE PASTED VALVE TYPE SACK WITH OUTER SLEEVE (TUCK-IN SLEEVE). After the sack is filled, sleeve is folded manually, down and back into the pocket under the sleeve, making a securely held positive closure against sifting. (Note section 2 for methods of positive sleeve closures.)



8—THE PASTED SATCHEL BOTTOM, OPEN MOUTH SACK. This sack is made of a flat tube, non-gusseted, with a factory made satchel type pasted bottom. After the sack is filled, top closure is made by tying with twine or with wire which is twisted manually or by machine. Top Closures are also made by gluing, stapling or with gummed tape. A sewn top closure is sometimes made.



9—THE AUTOMATIC (S.O.S.) PASTED BOTTOM OPEN MOUTH SACK. This sack is gusseted, with a factory made square type pasted bottom. After filling, top closuer is made by tying, gluing, stapling, sealing with wide gummed tape, or by sewing.

Top closures should be made equally as strong as factory made bottom closures. Sewn closures, when properly made, with bound-over tape applied before or after stitching provide strength and resistance against sifting.

10—BALERS are Sewn or Pasted Bottom Open Mouth Sacks designed for shipment of groups of small paper shipping sacks or pockets of sugar, flour, salt, rice, beans, peas, insecticides, etc., usually of 2 pounds up to 10 pounds capacities. Pockets are closed by sewing or pasting. Total Baler capacity generally is not more than 60 pounds.

There are many different pocket arrangements or groupings within Balers. Major requirement in Baler packaging is that pockets be nested firmly within the Baler, providing a tight, solid, compact unit load with no possibility of movement of pockets within the Baler during handling and shipment.

Baler closures are made by sewing or pasting and must be such as to hold the pockets firmly in place.

beyond the gusset. After the bag is filled, the operator tucks it back into the valve's interior. This is the most positive valve closure.

The insert sleeve is a notched piece of 40 lb. basis weight kraft which might be termed an interior valve block. This is merely a refinement of the valve on a simple sewn bag and, while not as positive as the tuck-in sleeve, does provide a better closure than a simple valve. Both sleeve insertions at the bag factory call for partial manual operations which retard production. Some automatic equipment for this operating is being developed.

After valving and sleeve insertion, bags go to the sewing tables where they are closed at both ends by opposed or staggered sewing heads. Complete inspection follows so that only good bags are wrapped and baled for delivery. Inspections also occur at every operation.

Pasted open mouth and valve bags are made in much the same way except that after the tubing operation the ends of the bags are closed on bottoming machines which merely fold one end in the case of open mouth containers and both ends for valve bags. Good bottoming practice calls for 2½" overlap on the ends for the sake of security.

On most bags of the pasted type there are but two dimensions, length and width. There is another type, known as S.O.S., which has a gusset and forms up into a carton shaped package. Relatively few of these bags are manufactured and they are generally used for insulation bat bags or balers.

Crinkled Paper Sacks

A variation of the multiwall bag as previously described, is one made from several layers of crinkled paper. This container is constructed as a sewn bottom, flat-tube bag and made up to 3, 4 or 5 plies each of 45 lb. basis weight. Each sheet of kraft is crinkled which provides a cushioning effect and lessens the degree of shock during severe handling and shipping conditions.

Although superficially this container resembles a typical flat kraft multiwall, the all crinkled multiwall construction gives it additional longitudinal stretch and in consequence more durability. This quality is the result of using "wet creped", or secondary creped paper, containing a minimum of 15 per cent stretch in the individual sheets. The 3, 4 or 5 ply bags are laminated with a light coating of flexible adhesive. This maintains the proper nesting of the plies until the bag is filled and closed at which point the light bonding ruptures and makes for greater flexibility of the container. The result is a tough

resilient paper bag whose overall construction enables it to expand and absorb unusual stress and strain, which in many instances might burst the average multiwall bag of the same total basis weigh. Creped asphalt laminated paper, constructed 45/35/45 may be incorporated in the crinkled bag where conditions warrant.

Since the crinkling process results in a deeply grooved "non-skid" surface, much of the stacking and shipping problems of the bags with smooth exteriors are avoided. As crinkled paper is relatively soft and flexible it offers hand-holds to packers and handlers and makes it more easily adaptable to nearly any type of sewing equipment.

This particular type of multiwall is especially recommended for the packing of hybrid seed corn, powdered milk, feed concentrates, dry adhesives and other relatively expensive items which require a premium container with the minimum breakage. The performance of the crinkled bag has been so excellent that producers of many low priced materials consider their products are "overpackaged" compared to the ordinary multiwall bag.

As far as limitations are concerned, there is hardly any product which is packed in textile bags which cannot be handled better and cheaper in multiwalls. Even hot asphalt and hot resins are poured into a paper bag lined with a special clay coated sheet in which the materials set up in block form. With the exception of a 50 kilo cement bag, the contents of a multiwall bag should not exceed 100 lbs. Current packaging trends are away from large unwieldy containers and the relative slipperiness of kraft paper compared to textile discourages the use of paper bags containing heavier weights. There are probably certain materials which have to "breathe" for which textile bags may prove more acceptable. However, flour, corn meal, alfalfa meal and cotton seed meal are packed and stored for long periods with no deterioration of these products.

Like all items produced on a large volume basis, some manufacturing errors are inevitable. Given a situation where the bags are made of paper meeting UU-S-48b and have been stored under the proper temperature and humidity conditions, made by modern and properly maintained equipment, mismanufactured bags can result only from poorly adjusted machinery. A well organized inspection crew should catch most poorly produced containers. On pasted bags, assuming that tubers and bottomers are properly set the only variable which might cause difficulty is the quality and application of the adhesives. This is not always apparent upon inspection. Sewn bags can fail for manufacturing reasons if the sewing and tape are not properly applied. Valve bags of both types cannot be packed satisfactorily if the valves are distorted or the various types of sleeves inserted or attached improperly.

Storage

The majority of troubles and the basis for most customer complaints arise from failure to recognize the need for well conditioned storage rooms. Most difficulties are experienced by those who have used some other type of container and convert to multiwalls. Cement companies where multiwalls have been used for many years, follow a rotating system where the latest delivered bags replace those which have been stored in conditioned warehouses. This avoids using sacks which left the factory in good condition but may have become dehydrated in transit. This can occur in hot summer months or extremely cold weather when delivery of a car is unusually delayed. Unfortunately, inexperienced users of paper bags may store them in unheated warehouses where sub-zero temperatures cause weakness of the paper. If bags are close to heating units this same situation can develop. Exposure of paper bags to open bins of certain chemicals can also cause deterioration. Fortunately, multiwalls respond quickly to proper atmospheric conditions. Through education of customers and distribution of the Chase pamphlet on proper storage of paper bags, we hope to lessen complaints on this most common reason for multiwall failure.

Other Troubles

There are several additional reasons for unsatisfactory performance of paper bags. The troubles occasioned by the underpackaged container are common to the buyer whose prime interest is to cut corners. This penny-wise practice is always costly in the end. The construction of any multiwall bag should be predicated on the worst handling, shipping and storage conditions to which it may be subjected. Especially is this true of a consumer who is packing his first lot of paper containers. Experience usually dictates the optimum construction. Cement bags containing 94 lbs. vary in basis weight from 150 to 210 lbs. As an industry, cement producers have had more experience with multiwalls than any other. The wide variety of shipping and storage conditions to which cement is subjected is the deciding factor in their choice of bag makeup.

Automatic packers out of adjustment, sewing equipment in poor repair, filling tubes and loading chutes with burrs and projections all offer hazards to paper bags. Failure of the packers to inspect and properly line freight cars often bring unwarranted complaints on paper bags. It is unusual to receive such complaints from those experienced in handling multiwalls which illustrates the need for education.

Prior to World War II kraft used for multiwall bags was merely known as "cement bag grade". Obviously this general term allowed a wide variety of quality. Multiwall bags came into prominent use for Government purposes, during the emergency period, particularly for overseas shipment of subsistence. Failure of many of these containers called for investigation and it was found that there was considerable variance in strength characteristics. At the request of the commissioner, Federal Supply Service General Services Administration, the Paper Shipping Sacks, W. P. B. Advisory Committee in conjunction with its technical group set up specifications for the types and quality of paper and complementary items such as tape, thread, etc. Most importantly, standards for natural kraft and wet-strength kraft were established, calling for minimums of tear, tensile, porosity, acidity and stretch, when such papers were to be included in multiwall sacks used for Government purposes. This is titled "Federal Specification Sacks, Paper, Shipping UU-S-48b".

Whether a bag manufacturer is integral or a converter, these specifications serve as criteria for "raw material". Representative tests are made under TAPPI conditions to determine the quality of each run of paper. Most multiwall plants maintain laboratories for the purpose of testing all materials which go into bag fabrication.

Someone has remarked that the horizon for paper is infinite and so are the unlimited possibilities of multiwall paper bags. This is supported by the gradual transition of most textile bag manufacturers to the production of paper bags. The development of new types of paper and adhesives for particular packing requirements, development of improved bag making and printing equipment which allows adaptation of multiwalls for new products, is typical of the industry. Despite the increase in bulk shipments for certain materials, the adoption of paper bags in new fields indicates that this container's popularity will become even more wide-spread.

Specialty Bags

C. P. Spring

Chief Chemist, Chase Bag Co.

Last week you heard a talk on a clearly defined subject—the multiwall shipping sack. I could wish that today's subject might be as clearly defined, but unfortunately the term "Specialty Bags" seems to be open to a variety of interpretations from different segments of the industry.

Perhaps the definition itself is not so important. You are probably interested in simply hearing about a variety of paper bags which consume a substantial tonnage of paper every year.

We consider two general classes of specialty bags—temporary or one-time-use bags, and consumer packages.

First let us look at some specialty paper bags which are used only once —flexible packages not usually designed for shipping or prolonged kitchen shelf use:—

Grocery bags.

Millinery and notion bags.

Garment and laundry bags.

Bags for bread, nuts, and other foods.

Most of these serve to help you carry articles from retail stores to your home. They will protect the contents from dirt, and even have some resistance to the elements. Few of them are designed to carry heavy loads. In a way many of them are simply substitutes for wrapping paper, and although they are converted products and therefore more costly than wrapping paper, they are more economical in the long run because they can be filled and closed quickly with a saving in costly time for the store clerk. Many of these bags, of course, are most attractively printed and help to merchandise products which are factory-packed.

C. P. Spring, Chief Chemist, Chase Bag Co., Research Laboratory, Chagrin Falls, Ohio, is a native of central New York state. He obtained his B.S. degree in pulp and paper manufacture from New York State College of Forestry, Syracuse, N. Y. in 1937. He was a Chemist with Riegel Paper Corp. Milford, N. J. from 1937 to 1940; Chemist with Chase Bag Co., Chagrin Falls, Ohio from 1940 to 1944 and Chief Chemist with Chase Bag from 1944 to date.

Grocery Bags

Grocery bags, including that workhorse, the cash-and-carry bag, must be stronger than most other single use bags for the grocer loads them up with canned foods, glass jars, and boxes with sharp corners. Southern unbleached kraft paper of an inexpensive type developed just for this purpose is almost universally used. Fourdrinier paper machines running at speeds practically up to 2,000 feet per minute turn out this paper in basis weights of 30 lb. for the small sizes up to probably 60 lb. for the large sizes. The grocery bag sheet is long fibered and fairly open in formation. Extremely smooth finish is not considered vital. A moderate amount of resin sizing is used to keep the paper from wetting too rapidly. Physical tests are quite high, with better quality papers running only about 10 per cent under the strength of multiwall shipping sack kraft. A definite effort is made to keep the machine direction tearing resistance and the cross direction tensile strength high so that bags will not split down the middle.

Sometimes a wet strength treatment is added to keep the bags from going to pieces so readily when they become damp. After all there is nothing so annoying as staggering under the burden of two huge bags of groceries and all of a sudden finding that a wet head of cabbage or a box of frozen food has worked its way out through the side of the bag and is threatening to let all the rest of the groceries fall to the sidewalk.

Millinery and Notion Bags

Millinery and notion bags are most familiar to us in the 5 and 10 cent stores, department stores, and hat shops. Many of them are really dust covers. Some are made from light-weight machine-glazed paper, produced on Yankee paper machines having only one, or perhaps just a few very large dryers. A great deal of machine finished paper is also used.

These bags are usually the flat style and are turned out at high rates of speed on automatic bag making equipment which forms a simple fold-over bottom. Printing is accomplished directly on the bag machine with press attachment using oil or aniline inks.

Garment and Laundry Bags

Garment and laundry bags are usually made from light-weight machine finished kraft paper on equipment similar to that used for millinery bags. They are often printed with the name of the dry cleaning or laundering establishment. A special adaptation of the folded-bottom produces the slanting shoulder line of the dry cleaners' bag which matches the slope of a coat hanger. In

the laundry bag, a special twine and button closure may be used.

Bread Bags

Bags for bread, nuts, and other foods are designed with something more than dust protection in mind. They are also intended to protect baked goods and other foods from moisture loss, and so they are often made from waxed paper. At the same time, attractiveness is a feature which can be gained by using a white paper and also by printing a brand name or design on the bag. The base papers can be white sulphite, bleached kraft, or glassine. Resistance to grease and oil, of course, is gained by the use of glassine paper, sometimes alone and sometimes as the liner of a two-wall or duplex bag. The newest type of bread bag used by bakeries which sell loaves of fresh bread across the counter is made from an opaque white sheet with a coating of wax. This gives a type of protection comparable to the waxed wrapper used on prepackaged sliced bread.

Potato chip bags can be dressed up in metal foil—excellent for display and moisture protection — but definitely a competitor to paper. Cellophane is in the same category, replacing lacquer coated glassine in many applications.

I am sure you will agree that the onetime use paper containers we have been talking about provide a distinct service to our way of living; that their development over a long period of time has shown a great deal of ingenuity; that there is tremendous technique involved in their production and in the manufacture of the base papers. Yet the same can be said for the paper sacks which are used for fresh produce, flour and other cereal products, citrus fruits, dry dog food, sugar and a host of other products. These can be called "Consumer Unit Bags." These bags must embody carrying capacity, eye appeal for retail sales, useable closures for the housewife, and provide whatever protection is necessary for keeping the contents in good condition or preventing the contents from marring the attractiveness of the package.

Such bags will hold from 2 lb. to perhaps 25 lb. of a commodity. They go on display in the stores, but they also have to hold up in rail or truck shipment. A group of them is often put into a large outer container bag or a carton so there will be fewer units to handle in a truck-load or carload shipment. There seems to be no clear-cut way to separate consumer unit bags into groups, so let us consider them in random fashion.

Family Flour Bags

Family flour bags appear on the grocer's shelves as brightly printed carton-like packages in 2, 5, 10 and 25 lb. sizes (although the amount of baking done in the modern-day home seldom involves the largest size mentioned). The outer surface is coated with casein- or starch-bonded white clay. The interior surface is colored blue to heighten the whiteness of the flour. The paper is embossed with narrow ribs running from top to bottom of the bag.

Most flour bags are of single wall construction with a satchel type bottom (the term "satchel" is used because the folded bottom looks like the old fashioned valise or satchel). Some are being made with the automatic or self-opening square bottom.

This is really a rather historic package—perhaps dressed up a bit in the last 25 years, but dating back way before the turn of the century when the paper from which it was made was composed entirely of old rope fibers turned into a strong and pliable sheet. Nowadays a major furnish of the sheet is kraft fiber. Small sizes are usually 100 percent kraft, and the paper may be made on a fourdrinier machine, using a calender stain to color one side a deep blue. Usually, however, all weights from 60 to 100 lbs. are made on cylinder machines with three cylinders—one for the blue side and two for the white side. This flour bag sheet is long fibered for suppleness and high tearing resistance, but at the same time every effort is made to retain 100 percent mullen and high tensile strength in both directions. The good bursting test generally goes hand in hand with the high machine direction tensile found in a cylinder sheet. Production of flour bag paper is usually slow—between 100 and 200 feet per minute—perhaps a little more in some mills.

The paper usually goes through a secondary coating operation, although our company is using a two stage machine coater which applies the necessary ten to fifteen pounds of white clay coating directly on the paper machine. Corrugating is done as a separate operation. It is an embossing of ten to sixteen ribs to the inch, runnnig in the machine direction, pressed into the paper by means of two steel rolls or one steel and one paper roll with matching ribs. The corrugations lend flexibility to the sheet and allow the mouth of the bag to be compressed easily for hand or wire tieing.

A variation of the blue-lined, white-coated composition rope and kraft flour bag paper is the 100 percent white kraft sheet. It is used in fairly large volume by at least one large flour packer. This paper is neither coated nor corrugated. It may be made on either cylinder or fourdrinier machines. It may well prove to be a sheet of increasing importance in the future.

Filling and closing the family flour bag is usually done on high speed automatic equipment. Bags are fitted onto packing tubes by hand, and a charge of flour of the proper weight is put into the bag. Conveyors take the bag away from the packing tubes and carry them over a jogging section, where vibration helps to settle the flour in the bag, then delivers it to the closing equipment.

There are several different types of closing methods. One is to gather the neck of the bag and wrap a wire ring around it. This is usually done on large sizes only. It is a difficult closure for the housewife to use, because the only practical solution to opening the bag is cutting off the neck of the bag below the wire ring. A second way is to flatten the mouth of the bag and fold it down over the contents, securing it with either adhesive or gummed tape. One of the most popular ways—particularly for the small packages but also including the 25 lb. size—is to form the so-called delta-seal closure. This is done on automatic equipment which fold in opposite sides of the mouth, leaving triangular shaped ears at the front and back. These are then glued down, one over the other. The housewife is supposed to raise one of the ears, cut off the corner of the triangle and form a spout from which the flour can be poured.

You can realize that high speed automatic operations of filling and closing put a great many requirements on the bag and the paper. Briefly, bag sizes must be kept within narrow limits; the paper must have enough absorbency to dissipate moisture from the glue used on the closures and allow it to set within the time limitations of the machine; the paper must have the correct stiffness to form into a carton-like package, and enough finish to slide properly on packing and closing devices. In the larger sizes of bags, the coated paper must have enough porosity or depth of corugation to allow air to escape during the packing operation.

Sugar Bags

The 5 and 10 lb. sizes of sugar bags are most popular. They are made from two walls of 40 and 50 lb. kraft paper—an inner ply of natural, and an outer ply of light natural or bleached kraft. The outside sheet is often col-

ored—beige and yellow are popular shades.

Due to the packing equipment which certain customers use for sugar, they need an extra smooth outer sheet. This is an added requirement of control for the mill making the paper. Other than that, the sheets are made to strength requirements about like those of multiwall specification kraft in the natural color.

Two types of sugar bags are made, either flat bottom or automatic (self-opening square). The first is usually pasted shut by the delta seal method; the second by a sewing machine which stitches through narrow kraft tape applied to both sides of the mouth of the bag and also clips off any excess paper above the sewing line. There is one special feature in sugar bags—siftproofness of the bottoms. The inside and outside sheets are slit and folded at different points so that when the bottom is formed the outer layer seals off the points of leakage that are inherent in the inner layer. This keeps sugar from leaking out the bottom of the bag.

Duplex Automatic Bags

This type of bag is used for quite a number of varied products such as dry dog food, soap powder, and wallpaper paste. One feature is the special tin tie closure which is often used in place of the usual sewn or pasted closure. A flap of paper on one side of the tie is pasted to the mouth of the bag. I am sure you are all familiar with the way the top of the bag is rolled down and the extensions of the metal are turned in to lock the folds. The whole idea is to provide a closure which can be used over and over again to protect the remaining contents of the bag after a portion has been used. It will keep the product from spilling out if the bag is accidentally tipped over on the kitchen shelf. Another feature is the use of a grease and oil resistant sheet as the liner or inside ply. Many products contain oil and grease which, if not confined inside the bag, would penetrate through to the outer sheet and make the shelf package very unsightly in appearance.

Coffee Bags

Coffee bags form a substantial field all by themselves. One of the most distinctive features of the coffee bag is its colorful and glossy print job. The outside sheet is often super-calendered to provide an exceptionally smooth surface for printing. The inks are high gloss, and it is not unusual to see an overall print job used to provide the tops in eye-catching appeal.

The inside sheet of the coffee bag is glassine, used to retain the oils in the coffee. Air flow in and out of the package is retarded by the denseness of both sheets of the bag, so aroma and flavor are retained better than they would be in a bag of porous paper. The resealable tin tie closure also helps in this respect.

Potato Bags

Here is an instance where bag makers have taken full advantage of modern developments in paper technology, and have worked out a package to hold damp potatoes. Essentially, potatoes are mostly water, and in addition many of them are washed before being packed. The problem of consumer size potato bags was hard to lick until the development of wet strength paper, treated with urea formaldehyde or melamine formaldehyde resin. Nowadays a good share of all potatoes is packed in some kind of paper bag.

Potato bags are made in either automatic or satchel type. Wet strength paper is used for one or both walls, where it prevents breakage of the package and reduces scuffing of the outside surface when the moisture from the contents makes the paper damp and soggy. Ventilation, to prevent condensation of moisture, is provided either by punching holes in the bag or by using a window of open mesh textile material. The latter gives some visibility to the contents as well as ventilation. In all of these bags the manufacturer uses a water resistant glue which teams up with the properties of the wet strength paper to provide a package which will not fall apart when it becomes damp.

An open mesh woven potato bag.

Printing and Bag Making

Before we go on to another type of bag, we should talk a little about the general printing and bag manufacturing operations for all of the paper bags mentioned up to this point. The development of an attractive and appealing brand for a consumer unit paper bag depends upon using clear-cut and colorful printing. In large volume production roll stock of the correct width to make the bag (or in multiples) is printed continuously and rewound into rolls and then placed on the unwind stand of the bag making machine. Probably the most generally used printing method is letterpress, employing inks and drying methods which preferably produce glossy printing. Much of the work is done in three or more colors. In runs of small quantities where it does not pay to set up a web press, the bag tubes may be printed one by one on rotary presses. This is done, of course, before the operation of bottoming.

Actual manufacture of the bag takes place on automatic equipment which pulls paper from rolls over formers to make a tube, then cuts off the proper length of tube and forms the bottom of the bag. Other operations along the line are: applying paste in dots or bars to hold the plies of the bag together, applying the paste for making the longitudinal seams, making the slits for bottom formation, registering the printing correctly for each tube by electric eye control working on register spots printed on the outside sheet, and applying adhesives to the paper points to make the bottom.

Troubles

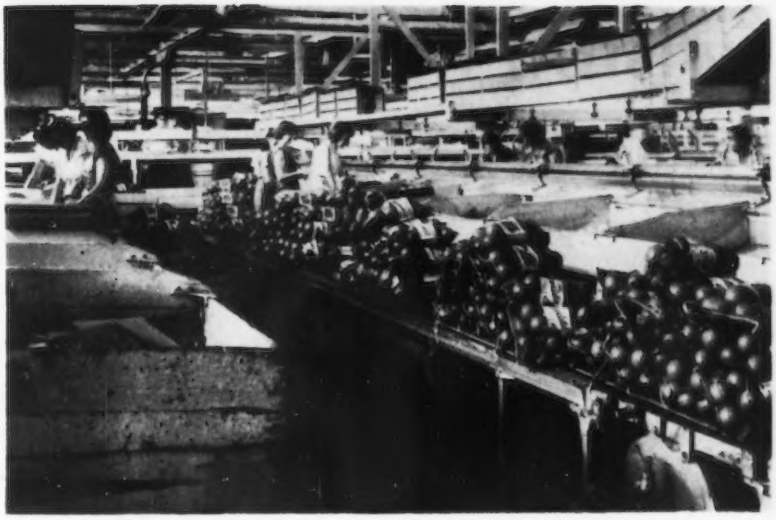
As in any high-speed complicated operation, there will be difficulties with the raw materials, the converting operation, and in the final use of the bags. I should like to save some time by referring you back to the difficulties which were described to you last week in connection with multiwall shipping sacks. I do not mean to minimize difficulties encountered with specialty bags, but they are most similiar to those of multiwall sacks which are made on more or less the same type of equipment from the same general materials.

One additional precaution we have to face in consumer units is that the contents of the bag do not spoil the attractiveness of the package. This means that grease-resistant sheets must function properly or there will be ugly oil stains on the otherwise attractive outside sheet. Wet strength paper must be properly treated with sufficient resin so that it does not scuff

under the effect of the vibration of rail or truck shipments. Proper moisture content of the paper, proper bag size and freedom from mechanical defects such as poor pasting, improper nesting, poorly formed bottoms, and accidental cuts are as important in specialty bags as in multiwalls.

Open Mesh Woven Paper Bags

Here is a woven textile material made from paper! The yarns of open mesh paper bags are made from strips of paper and are woven into a cloth which is converted into bags in the same fashion as cotton and burlap. Some vegetable bag material is actually made from cotton, but it has certain draw-backs which the woven paper material does not have. Cotton has a tendency to stretch so that the bag appears not to be filled to capacity, and the fine cotton yarn often has the tendency to mesh-mark the surface of vegetables with tender skins like potatoes.



Oranges being packed in open mesh woven paper bags.

Open mesh woven paper bags are used for consumer units of potatoes, citrus fruits, and other produce. In bulk shipping sizes they also carry 50 lbs. of onions, beets, cabbage, or carrots. They provide excellent ventilation and almost complete visibility to the product.

The base paper is Northern kraft, running in basis weight from 25 to 35 lbs., 24x36—500. It is used in natural kraft color, semi-bleached with a G.E. brightness of 55 to 65, and full bleached white.

The sheet is long fibered and fairly well hydrated, although not enough to make it exceptionally tinny. A soft sheet is quite desirable so the yarns will be flexible. High machine direction tensile strength is a requisite—at least a pound of tensile for every pound of basis weight. The sheet is dragged on the fourdrinier paper machine to line up the fibers in the long direction. This is generally aimed toward having three times as much tensile strength in the machine direction as cross machine. The sizing is low so that the spinning and coloring solution can penetrate the sheet easily. Because of the narrowness of the strips of paper which are twisted — roughly ¼" — the formation must be even and free from mechanical defects such as wire marks, slime spots, bubble spots, and foreign material. The sheet normally has a low finish obtained by using 1 nip on the calender stack. This helps to keep the very narrow slit rolls from falling apart as they would if the finish were very smooth.

Wet strength resin may be used in spinning kraft to help it hold up during the twisting operation or to provide wet abrasion resistance to the cloth. One type of open mesh bag in the 50 lb. size is used for vegetables which must be preserved during freight car shipments by keeping them cool and damp. They are known as "wet-pack" quality. After the car is loaded, a layer of shaved ice is blown over the top of the bags. This keeps them soaking wet during their trip to the market, and wet strength paper yarns do hold up better under the abrading effects of vibration—particularly if the bags contain rough vegetables like carrots or beets.

The slit rolls of paper are converted to yarn on ring-type twisters similar to cotton spinners. The strip is unwound continuously from the narrow disk, dampened with soluble oils in mixture with water, which may also contain aniline colors for producing the bright shades. After dampening, the narrow strip is folded in from both edges, and then the twisting operation puts in about 5½ to 7 turns per inch of twist. The yarn is wound on large bobbins which are placed on racks or creels back of the looms, or are rewound onto smaller bobbins used in the shuttles.

Weaving takes place on looms which are adaptations of those used in the cotton cloth industry. The fabrics for 50 lb. bags usually have a yarn count of 6½ yarns per inch in the warp and 6 yarns per inch in the filling. Consumer size bags are woven in lower counts—down to 4 by 3—with a leno weave, wherein the warp yarns are brought together in pairs and are criss-crossed so as to lock the filling yarns in place.

The Association of American Railroads publishes specifications which cover the required tensile strength, in both wet and dry condition, for open mesh woven paper material used in bags. It is the joint problem of the paper maker and the converter to build sufficient strength into the spinning kraft and into the spun yarns, and to use a high enough count fabric to pass the railroads' specifications.

By virtue of the narrowness of the strips of paper which are made into yarns, multiple troubles can crop up in the converting operation. Mechanical defects in the sheet can cause excessive breakage during the twisting operation; improper sizing can cause rough, wiry yarn; insufficient strength will prevent dampening the strip enough to make a smooth yarn. Even if the strips get through the twisting and weaving operations satisfactorily, if they do not have the correct amount of twist, or if they are rough and wiry, they may not exhibit enough tensile strength to pass the railroad shipping requirements. Again, if they become mushy when they are wet the bags may fail in transit.

From the consumer's viewpoint, the package must be attractive. The latest trend is to glue a band of paper at the center of the goods so that printing will show up prominently. The dyes which are used to produce the bright colors of the cloth must have characteristics of resistance to bleeding, fading in sunlight, or rubbing off; sometimes all three are required simultaneously. The end product is a premium package for extra quality produce.

Twisted Paper Products

T. M. Sellers

MacLean Advertising Agency of New York

Twisted paper products are, by this time, quite well known and most of us have seen them at work in one form or another. They were developed in the same spirit of research and experiment that makes possible the high quality performance of other modern textiles. Similar to other textile advances, necessity and practical economic advantages gave them impetus at times when they might otherwise have been neglected. And, like so many present-day innovations, the raw materials for for their making have always existed but only today are we begining to see the complete scope of the vision their skillful manufacture and wide use present.

The student of modern textiles, therefore, sees before him the beginnings of a vast and immeasurable potential textile science which includes the unique characteristics of twisted paper in all its forms.

Among textile students, as in the case of science students generally, a definite and understandable language has developed through the years to contain their ideas. Thus, when you say weave, thread count per inch, etc., the meaning is instantly clear. Paper yarns, and fabrics, however, do not share the terminology of other textile fibers. This is due mainly to the different grades and weights of papers available. There is, in fact, a genuine need for a simple terminology of standards and specifications in the trade which will encompass these varying qualities and conditions.

First, therefore, a definition. Any yarns, cords, braids, or twines that are made entirely of paper, or use paper as a major component, are known as twisted paper products. By "twisting tissue," we mean papers from 12 to 20 lb.; by "twisting papers," we mean papers from 25 to 50 lb. Both are versatile and adoptable to various types of weaves—plain, basket, twill, etc.—to suit different uses. The choice of weight and weave depends upon the end use and the characteristics desired in the finished product. Some papers are hard and tough, others are soft and pliable.

Theodore M. Seller was born in Detroit, Mich. and educated there and in New York at Pratt Institute. He entered the advertising field as copywriter, later rising to account manager with McCann-Erickson, counselling large national accounts. As President of MacLean Advertising Agency of New York, Mr. Seller directs the advertising and public relations service on the Agency's accounts, including the Fibre Fabric Group of the Tissue Assn.

History of Twisted Paper Fabrics

In our time—overlooking authenticated references to their early Oriental use—paper cords were first produced from finished paper in the late 19th Century. Patents granted to Emil Claviez between 1895-97 are the first recorded notices. They were first manufactured in Germany and, subsequently, in Austria and Sweden. Research quickly discovered unsuspected uses for the new fibre.

In 1910, in France, Claviez developed a method of making yarn from paper which had been coated with an adhesive on both sides. To this he glued cotton, or combing or napping, depending upon the end use of the yarn, thus creating the first practical forerunner to modern core yarns. Claviez' fabric was quite amazing for the period. It had a warp resistance of 169 lbs., an elongation of 12.5 per cent, a filling resistance of 109 lbs. and a filling elongation of 33 per cent. It could be washed, bleached, dyed and very easily printed.

About this time Paul Ebenhouse, in Germany, using the Claviez patents as a starting point, produced a further variation by combining spun paper and cotton. By the time of World War I these separate advances had assumed major economic importance.

Under the stress of restricted war imports, the use of twisted paper fabrics in Germany, Austria, England and France reached "tremendous proportions" (1). Cartridge belts, sand bags and other textile needs of war quickly were converted to twisted paper fabrics. In Germany, clothes for civilians were made of 40 per cent cotton, 20 per cent wool paste yarn and 40 per cent twisted paper yarn. As clothes they were not the finest but as wartime protection against the weather they performed a valuable service.

Subsequent development of paper into cordage was a natural one. It varied from twine to coarse rope. Sometimes the paper was spun on a core of fine hemp twine or on a metal wire. From these followed the manufacture of sacks, using the open weave paper fabrics we see today, for all grains, flours, potatoes, fertilizers, salts, wool, etc. These bags were particularly adaptable since they were free from odor and had no loose fibers that could become mixed with the contents. A serious shortcoming, however, was their tendency to disintegrate under extreme conditions of weather.

Before World War I was over, both Germany and Austria had developed a variety of other uses: braiding, tent canvas, tarpaulins, mats, upholstery and carpeting materials, wall coverings, foundations for linoleum and oil cloth, and even woven boards said to form a suitable substitute for plywood.

One of the most noteworthy developments of this time was a twisted paper fabric substitute for leather machine belting. The yarns were spun from parchment paper, impregnated, and the woven fabric was stitched to-

gether to make belting of the desired thickness.

In the cable industry, impregnated yarns were first used as a substitute for jute as packing between the lead sheath and iron armor of the cables. Paper yarns are more efficient than jute as an initial protective wrapping for this purpose since they blend with the composition and adhere readily to the lead sheath to form a perfectly flexible and waterproof covering. This application continues unchanged to this day.

During this period, probably more creative experiments took place in Germany and Austria than elsewhere. Sweden, however, trailed closely. During the latter years of World War I, paper yarns were used primarily for binder twine and, to a lesser degree, in textiles and some forms of wearing apparel. As is often the case, however, despite the notable technological advances of the period, a productive capacity without quality control and performance standards resulted in the dumping of many imperfect substitutes on the market in postwar years.

The interval between World War I and World War II saw many interesting developments. In England and France twisted paper fabric was used as a backing in rugs and carpets under the name Textilose. (It is interesting to note that a 2" x 8" sample of Textilose shows the following test results: warp resistance, 169 lbs.; elongation, 12½"; filling ressistance, 109 lbs.; elongation, 33%.) Today almost 50 per cent of the carpets manufactured in the United States have backings made of twisted paper products. In this country twisted paper fabrics found their way into furniture and allied industries, giving birth to a widely accepted variation of the expensive and imported porch chair and furniture so characteristic of the period.

In Germany, in 1940, a binder twine was made from filament viscose but experiments quickly proved that the best production potential existed in twisted paper, or fiber fabric, products. A Leipzig factory attained a production of 40 tons monthly, using special Swedish paper with a breaking length of 13,000 metres, a stretch of 2 per cent and a weight of 40 grams per square meter. Production was controlled by the uniform testing of samples sent monthly to a central testing station. (2)

In Sweden, during World War II, the jute industry seriously entered into the manufacture of twisted paper products. Postwar, the boom continued, largely because Sweden had learned its lesson from the first war and had established a Textile Commission to insure uniform testing methods and high quality standards for their manufacture. Here twisted paper yarns were used extensively to manufacture fiber rugs. The results were eminently satisfactory for commercial uses, the fiber rugs wearing five times as long as the jute rugs (3). There was, of course, a price advantage in favor of twisted paper products, including yarns and fabrics, due to the restricted import situation in other natural fibers but, nevertheless, twisted paper products held their own and won acceptance for many common purposes. "Easy to handle, very suitable for small packages, can be produced in colors that appeal to retail customers," was the verdict on tying twine. (4)

Our American contributions to the development of twisted paper products, or fiber fabrics, have been in the direction of improved quality, higher rates of production and lower cost of manufacture. Quality control at all stages of its manufacture and rigid standards of performance for the end product have most recently received wide acceptance among paper manufacturers and converters.

Papers Used

Twisted paper products, as we know them, are produced almost exclusively from kraft paper, bleached or unbleached. These papers, in almost every case, are most suitable. Both fourdrinier and cylinder machines are suited to making paper used in twisted paper product manufacturing. There are, of course, special preferences for each type of machine, some vocal and heated, all documented. The cylinder machine has a range of weight from 7 lbs. to heavy board and a characteristic of greatest tensile strength in the machine direction. The fourdrinier machine produces papers in a range of from 7 to 100 lbs. and its sheet has less difference in tensile strength between its machine direction and cross sheet.

Methods of Manufacturing Twisted Paper Products

No matter which type of paper is used, the method of manufacturing twisted paper products is the same. The steps, simply reviewed, will be recognizable:

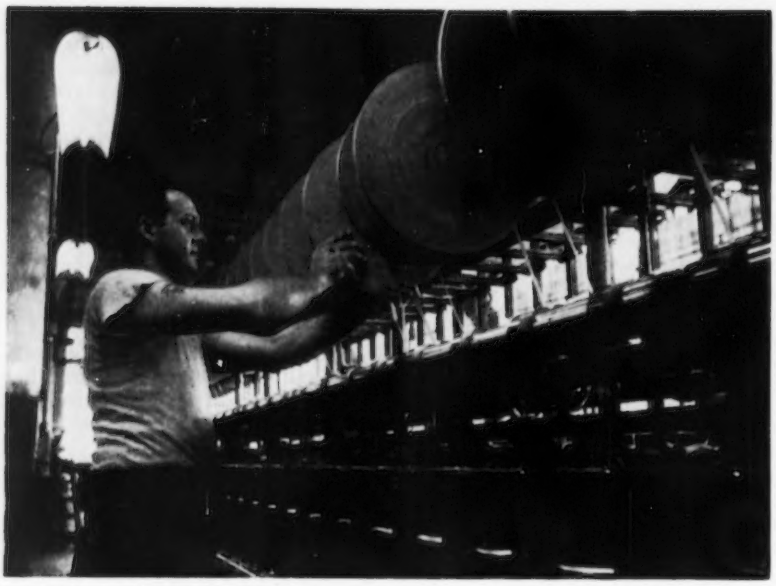
1. The large, jumbo rolls, weighing about 1,000 lbs. each, are placed on slitters and cut into pads or reels of various widths (¼" to 1¼") depending on the thickness and quality of the desired end product.

2. The paper is wound onto spools, each spool holding between 1,000 to 4,000 yards of yarn.

3. Twisting, the mechanical change from ribbon to strong yarn, takes place right off the individual spools. The extensive yardage in each pad helps keep the yarn free of knots, thereby insuring a smooth surface. "It is important that the paper be uniform and well felted, strong, tough and flexible, and completely lacking in cloudy and loose formations. High breaking lengths are essential; values of 10,000 to 12,000 m are quite usual." (5)

4. The spool of various colored yarns (126 colors and shades have thus

The first step in the precision manufacture of fibre fabric sees the rolls of special kraft paper machine-slit into "pads" or reels of various widths (¼" - 1¼"), depending on the thickness and quality of the fibre fabric desired and depending on whether it is destined to be used for auto seat covers, auto trunk matting, in luggage or for floor covering.

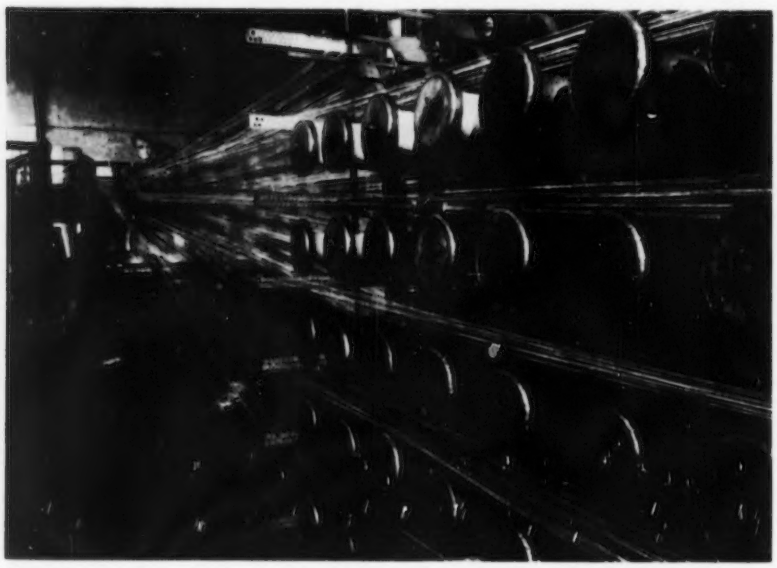


Next step on the production line toward becoming fibre fabric is this operation of twisting the paper pads into yarn wound onto spools. Each spool holds between 1000-4000 yards of yarn. Twisting the paper ribbon makes the resulting yarn stronger than the paper was in its ribbon form, giving the end product longer wearing properties. The extensive yardage in each pad helps keep the yarn free of bumpy knots, thereby helping to insure a smooth surface.

far been developed (are arranged according to quantity and sequence in the creel. They are then unwound under equal tension onto a huge steel spool, or "beam." The average 63" fabric beam requires from 800 to 2,000 spools to create the warp pattern. Each of these huge steel cylinders can hold up to two million lineal yards of yarn.

5. Shuttle and loom take over to produce a wide variety of patterns and color combinations.

Step No. 3 requires further explanation. Placed on the twisters, the pads —depending on whether they are wet or dry—go through pans, or over rollers, or are dipped, then seasoned in controlled humidity chambers.



The fabric pattern begins to take form. The spool of various colored yarns—are arranged in the "creel," as the spool rack is called, according to the quantity and sequence the particular pattern calls for. The yarns are unwound off the spools at an even tension onto a huge steel spool called a "beam." This process, called "warping," is the very first step in forming the pattern and weave of the finished fibre fabric. The average 63" fabric beam requires from 800 to 2000 spools to create the warp pattern.

Moisture Control

The process of injecting moisture into the twisting operation has many variations. It is possible, for example, to precondition the paper at the mill. Whatever method is employed, the goal is to provide a more uniform product with a consistent performance standard.

In practice, it has been found that in order to be twisted properly, the sheet should have a moisture content of between 15-25 per cent. To attain this, there are two methods, one low-cost and effective for most requirements, the other more costly and tightly controlled.

The average jumbo roll is received off the flatcar with a moisture content of approximately 8 per cent. The first method, in effect, calls for dipping the pads or "cheeses" which have been cut from the roll into water containing a wetting agent. With this method, the pad thus treated has a maximum amount of water at its lateral ends. Actually, this is beneficial because it permits the easier folding in of the ribbon in the twisting operation and produces a smooth yarn.

The second method is to run the paper strips off the pads between two rollers which rotate in a pan which contains water and a certain amount of wetting agent. Thus the sheet is wet uniformly across its width. In this method, a more exact control of moisture can be exercised.

As if in an effort to complicate our reasoning, but nevertheless to give vent to the atmosphere of free experiment which has entered the field of twisted paper product manufacture, we cite the experience of one authority, who says: "The best twists thus far produced were formed of the least hydrated fibers. Final strength was derived from mechanical rather than colloidal characteristics." (6)

Colors are obtained in the paper itself. Experiments for printing color on both sides have not reached the point where conclusive comment can be made.

Quality control, the essence of performance in any manufacturing process, is essential at all stages and levels of making the variety of twisted paper products. After the patterns is woven, quality control is exercised on tensile strength, abrasion and colorfastness qualities of the fabric.

Other methods for manufacturing twisted paper yarns are constantly being tried, developed and perfected. The use of wet pulp is one. With this method, the paper, as it comes from the cylinder, is split into ribbons by slitters

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or high pressure air streams and is then placed on reels and dried. This method produces a yarn which is actually stronger wet than dry.

Present Uses of Twisted Paper Products

Any list of present uses of twisted paper products would be incomplete since there is no way of knowing to what extent textile chemists and engineers are experimenting with its qualities. The following, therefore, is a list of those uses now commercially feasible and which are presently being marketed:

Automobile seat covers account for a great part of the market of both light weight and heavy weight twisted paper products.

Fibre rugs are utilizing more and more twisted paper yarns.

Upholstery and luggage use twisted paper products for trims, welts, linings, exterior coverings and bag handles.

Modern chairs are covered with fiber fabrics. Recently the Museum of Modern Art awarded a design plaque to a chair upholstered entirely with heavy weight fiber yarn.

Baskets for florists, fruit and gift shops and bottle twine for wrapping wine bottles are entering the field in increasing volume.

Shaped for tacking purposes, twisted paper products gradually are replacing wood for tacking upholstery in auto bodies.

Backing of regular wool-faced carpeting utilizes more and more fiber fabrics.

Imitation cane webbing used on many clothes hampers is heavily sized twisted paper given a hard finish to resemble imports from the Far East.

Matching handbag, hat and shoe sets are demonstrating the applicability of twisted paper products to fashion items.

Wool bagging, to some degree, is replacing burlap bagging for specific uses. This eliminates the clinging of the burlap fiber to the wool clippings, a condition which increases the cost of combing and creates the hazard of varying degrees of dye absorption and the resulting down-grading of wool quality.

Sand bags, also, are being made of twisted paper fabric.

New automobiles are enlarging their uses of twisted paper products. The Henry J uses a coated fiber fabric as its basic upholstery. Plymouth and the Willys Overland station wagon use it as a head lining. The trunk linings in the Kaiser-Fraser series and a number of other cars are made of fiber fabric.

Non-skid rug backings, the basis of one of the largest selling non-skid rug backings sold by Sears, Roebuck and Montgomery Ward, are manufactured of twisted paper products.

The filled warp is placed at the back of the loom ready to be fed into it as warp yarn to be interwoven with the fill yarn. The shuttles carrying the fill yarn are so arranged that they form the desired pattern when woven in combination with the warp yarn.

Transporting of water for irrigation and soil erosion treatment is an important new use of twisted paper products. It is particularly well suited for some types of installation.

Snow fences manufactured from twisted paper products are finding wider acceptance. This is a use which comes to us from Europe via Canada, where twisted paper products have been used successfully for this purpose.

Package strappings, made of twisted paper heavily impregnated and formed into flat strips, replaces steel for lightweight cartons up to 125-135 lbs.

Tying twine uses are multiplying. Wool fleece tied with paper twines do not pick up loose fibers. Twine used to tie waste paper merely dissolves should it deposit itself in the pulp during processing. Paper twine with a wire center treated to withstand moisture and weather is finding wide application as a nursery and garden tie for flowers, shrubs and other plants.

Future of Twisted Paper Products

Here we toy with destiny, for nobody knows. We see extruded twisted paper yarns, for one thing. Scientists

Fiber fabrics are now being woven in a wide variety of patterns and color combinations. The quality and variety of fiber fabric has been made possible by the industry's intensive equipment modernization program.

today are unceasingly pushing this type of experiment. Extrusion offers valuable cost-saving factors in the elimination of some of the manufacturing steps now required. It now remains only to perfect the process in order to secure wider performance possibilities and broader markets for twisted paper products.

In late 1951, E. I. du Pont de Nemours & Co., Wilmington, Del., made a report of a latex solution of neoprene which, applied to the chemistry of twisted paper product manufacture, could improve the performance characteristics and possibilities of all types of finished paper products.

Du Pont research has also enabled us to produce an improved fabric with the use of a special 16 basis paper with 5 per cent of an additive. When woven, this twisted paper fabric withstood the equivalent of five commercial launderings. In addition, abrasion resistance was increased three times. These are only beginnings in a specific chain of experiments which bear promise of almost incredible possibilities.

Goodyear Tire and Rubber Co., Dow Chemical Co. and Monsanto Chemical Co. are also working on additives. The Monsanto company has already established that the coating of paper twine with a flexible plastic called vinylbutyral (used prewar as an interlayer material for safety glass) will increase its resistance to water, wear, skidding, mildew and fading. This coating makes the twisted paper product relatively impervious to stains from ink, gravy, food and permtis efficient cleaning with a damp cloth. Design possibilities are unlimited since the weaver can choose his colors not only from the paper itself but, also, from the range of pigments permanently welded into the plastic.

There is a real need for technical talent in the twisted paper products industry. At is grows, it must attract engineers and technicians of the highest creative capabilities. Only by studying this field and making probing investigation into its ever-shifting characteristics can this kind of talent become informed of its enormous scope, variety and potential.

There are literally no limits to the performance possibilities of twisted paper products in the future. Our wildest imaginings cannot encompass nor accurately fix the dimensions of the product we are dealing with.

The most promising sign we see, in fact, is the technical road to be travelled. Textile students face a challenge in these problems: abrasion resistance, wet strength, cracking, flame proofing, water repellency, strength recovery, tensile strengthening, color fastness, serviceability.

In reality, twisted fiber fabrics are, in essence, a natural carrying vehicle for continuing gains in the chemical sciences. No other group of products will respond more readily to the attention paid them by modern chemists.

These, then, are the simple facts of twisted paper products, or fiber fabrics. What is happening in the laboratories and in the minds of creative engineers everywhere who know these facts cannot be told now. When they can be told, we will look back on today as only the small beginning of an unimaginable tomorrow.

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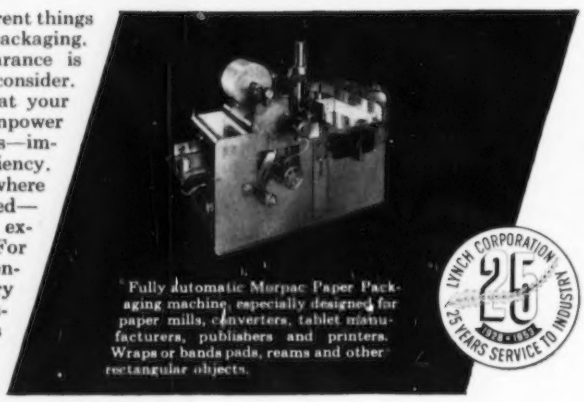

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Waxed Papers

Robert D. Caine

Kalamazoo Vegetable Parchment Co.

Robert D. Caine, a native of Ionia, Mich., is an alumnus of Michigan State College. After extensive travel in Asia, Africa, and Europe he joined the Kalamazoo Vegetable Parchment Co. in 1928. At present he is Manager of Manufacturing of the Parchment, Mich., plant.

All types of papers from tissue up to light board, impregnated or coated with a range of materials from petroleum jelly on one end, to complex wax modifications on the other, will fall in the general classification of "Waxed Papers".

The first wax machine was built about ninety years ago. It was crude in construction and in the job it performed. Since that first machine many developments have taken place both in the machine design and the materials used for impregnating and coating. The many advantages gained in the blending of paraffins, micro-crystalline waxes, synthetic waxes, and polymers have numbered the days of the straight paraffin coating.

Paraffins used in waxed papers are usually white in color, with melting points generally ranging from 100°F. to 150°F. Fully refined paraffins in the range of 130°-150°F. melting points are block resistant at normal temperatures and have fair sealing strength. They will provide good resistance to moisture vapor transmission when in continuous film and used uncreased. Because of their natural brittleness, some of their protective value is lost when paper waxed with them is folded sharply.

Microcrystalline waxes used in wax blends range in color, depending upon the degree of refinement, from light lemon yellow to a very dark brown, with melting points usually ranging from 130°F. to 185°F. They come in a wide range of hardnesses, which makes them suitable for many uses. The softer micro waxes are less liable to break down when folded, so are desirable for good moisture vapor proofness. Their tackiness makes them good laminants for combining paper to paper, paper to film, or paper to foil. The harder micro waxes blended with paraffins are good gloss formers.

From its humble beginning in 1864, the wax paper business has grown to an important segment of the total paper industry, producing in 1952 between 800 and 900 million pounds of the various wax barriers. This figure does not include the large tonnage of other treatments, such as white oils and petrolatums.

A very high percentage of this tonnage was produced for the protection of food products. Substantial amounts, however, are also used for wrapping soaps, tobacco, salt, wall cleaners, metal parts, candy, cough drops, gum and textiles. A very interesting usage of waxed paper is for vegetable row protection. This paper is placed over the young plants early in the spring. It protects them against freezing, retains the moisture needed by the young plant, and generally improves strong root development. With the use of row protective paper the truck farmer can do his planting much earlier and thereby gain a market advantage.

Waxed paper is probably best known as the most generally used barrier for holding moisture either in or out of a product. In the wrapping of bread, crackers, cookies and cakes, the function of the waxed barrier is to retain the moisture *in* the product. In the case of potato chips, cereals, and metal parts, its purpose is to hold moisture out. In many applications the comparative imperviousness of the waxed paper is the only important requirement, but not in the products mentioned above.

All of them will be displayed on a merchant's shelf and must have the appeal required for their selection over the competitive products by the potential purchaser. There must be an attractive design that properly identifies the manufacturer—a good gloss on the wax film to help snap up the colors of the ink used in the printed image and the proper moisture content in the wrapper so good wrapping machine operation is guaranteed.

If it is a package that may be on the shelf for some time, attention must be paid to its resistance to dust collection. If it may be carried home without additional wrapping, the rub resistance of the coating must be improved over that of straight paraffin.

The need of certain characteristics will dictate the blends and modifications used.

High gloss, reduction of dirt collection, improved rub resistance and sealing strength may be obtained by blends of hard micro-crystalling waxes, high melting point paraffins and a polymer which forms a hard surface film.

Dead fold, low temperature flexibility, good creased M.V.P. and stripping quality require blends incorporating soft micro waxes and paraffins of lower melting point. If the blend is used for surface treatment which will be subjected to low temperature, waxes having good anchoring characteristics are desirable to prevent wax pull off when product is stripped from wrapper.

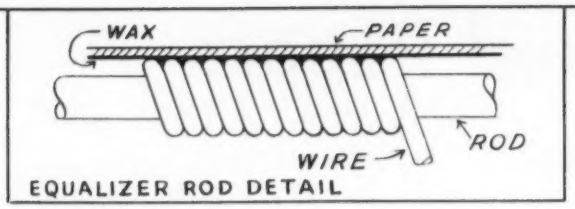
The desired performance can oftentimes be obtained in several ways. If a waxed paper end use requires considerable creasing and retention of good M.V.P., it would seem to dictate the softest wax obtainable. With softness, however, will generally come increased tackiness and blocking tendencies. Either the soft wax must be blended with harder waxes to gain maximum practical benefit from the soft wax or a material like polyethylene must be added to increase the blocking resistance. In some one-side applications of micro waxes starch is dusted on the coated surface to reduce tack, thereby reducing the tendency to block. This tendency, when controlled by proper blending, becomes one of waxes' major attributes: the ability to heat seal.

For each end use there is a particular set of conditions under which the waxed paper must perform satisfactorily. Paper is made up of many fibers felted together. Between the fibers there may be openings which will allow passage of water. Even in sheets which are closed well enough to prevent the passage of air, the fibre composition will allow water to wick through.

According to the end requirements of the wrappers, these fibre interstices are slightly filled, completely filled, par-

FIGURE I

MAYER WAXER



EQUALIZER ROD DETAIL

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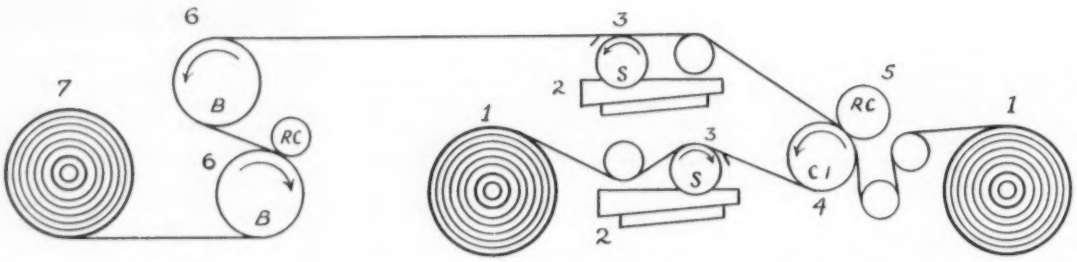
R. C. - RUBBER COVERED
B - BRASS
S - STEEL



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3-PICK-UP ROLLS
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6-COOLING DRUMS
7-REWOUND WAX ROLL

tially filled, and covered with light continuous wax film or covered with a heavy continuous wax film. Theoretically, these treatments will make the sheets, in the same order, water repellent, waterproof, moistureproof, or moistureproof and self-sealing. To be assured, however, that the latter categories are water-vaporproof we must be sure all fibers are filmed over with wax so they cannot act as wicks in transmitting moisture from one side of the sheet through to the other side. All of the above references to moisture vaporproofness are relative. Wax being a crystalline material, it will allow passage of minute quantities of moisture vapor.

The above descriptions very roughly identify the general classification of waxing—namely:

Dry Waxed — Wax in stock—no surface wax

Wet Waxed — Wax in stock — small amount on surface

Heat Sealing Wet Waxed —Same as wet waxing with sufficient wax on surface for heat sealing

Waxed One Side —Wax in sheet and on one side, or largely on surface of one side

Wax Laminated — Two or more sheets combined using paraffin, microcrystalline, or combination of both for wax-laminant. Sheets combined can be surface waxed or unwaxed.

Dry Waxed

Used in bakeries, markets, dairies, delicatessen stores and restaurants for slap sheets or outer wraps for greasy, bloody or wet foods, as sandwich wrappers, as a sanitary measure while handling and filling bakery cartons or as inner liners for ice cream containers. Dry waxed parchment is used extensively as a butter wrapper.

Stocks used for these papers are usually M.F. sulphite or kraft generally carrying small amount of wet strength, or genuine vegetable parchment which is lightly parchmentized. Basis weights of raw stocks used for dry waxing purposes will cover a very wide range. These will, however, usually fall between 10 and 70 lb—24 x 36-500. The amount of wax added is seldom more than 25 per cent of the paper weight before waxing.

For good wax machine performance it is desirable that these stocks remain uniform in wax absorbency, which is related to uniform finish, porosity, sizing and parchmentizing. There is no quick easy way to adjust wax temperature or change metering equipment for variation of these factors. Uniformity in raw stock is therefore very important for the production of a dry waxed paper with constant percentage of wax.

Some of the materials used for dry waxing are fully refined paraffin, semi-refined paraffin, crude scale, white oils and petrolatums.

Dry waxing is usually done on the Mayer type waxer (See Fig. I); however, some is done on the dip squeeze type. The Mayer waxer applies an excess of wax on one side of the sheet when it passes over a fountain type steel roll, the bottom of which is running in a bath of wax. The excess is then scraped off by a doctor blade or a wire wound rod. The gauge of the wire wound on the rod determines the amount of wax left on the sheet as the openings between the wire diameters allow passage of the wax. When speed, temperature of wax and sheet condition remain constant, the larger wire windings will allow more wax through. These openings result in heavier coating of wax on the paper.

After the desired amount of wax has been applied, the sheet passes over a series of steam-heated drums and is then wound up hot. When wound up above the wax melting temperature the saturating action continues until paper cools. This method of waxing gives a finished sheet an eggshell appearance.

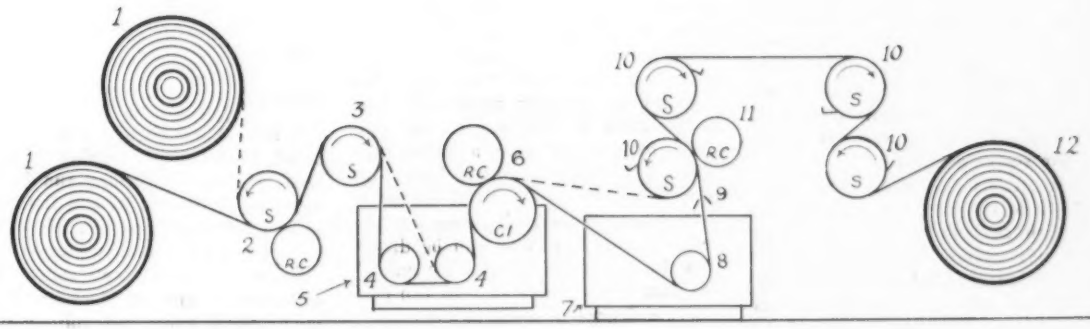
Wet Waxing

The term wet waxing refers to the continuous film of wax on the paper surface, the opposite of dry waxing

FIGURE 2.

DIP SQUEEZE WAXER

RC = RUBBER COVERED
CI = CAST IRON
S = STEEL



1-UNWAXED MILL ROLLS
2-PULL ROLL UNIT
3-HOT ROLL
4-WAX DIP ROLLS
5-WAX PAN
6-WAX PRESS UNIT
7-WATER DIP PAN
8-WATER DIP ROLL
9-WATER DOCTORS
10-COOLING DRUMS
11-R. C. SQUEEZE ROLL
12-WAX REWIND ROLL

wherein all the wax is in the sheet and the surface appears dry.

Wet waxed papers are those carrying varying amounts of surface wax but usually less than enough for good heat sealing. These papers are used as box and carton liners for products such as meat, fish, candy, poultry, cereals, cough drops, and as inner wrappers for soap, gum and bread. Locker and household waxed paper also fall in this group.

Strong sheets, both M.F. and M.G. sulphite and kraft, many carrying wet strength, are generally used for this purpose. These stocks are often beater or tub sized to help control wax absorption, strikethrough, softness and opacity. Genuine vegetable parchment, the original wet strength stock, is often wet waxed one or two sides. Basis weights of papers used for wet waxing will usually range from 15 to more than 100 lb.—24 x 36-500. The amount of wax applied will seldom be more than 50 per cent of the raw stock weight. The waxes used on these products can be refined or semi-refined paraffins, paraffin, micro-crystalline blends and blends incorporating all three of these waxes.

The dip squeeze waxer (See Fig. 2) is used in the production of the majority of wet waxings. This will apply wax to either one or both sides by a steel roll running in a wax bath carrying the wax up to the sheet and acting as a metering nip formed with a rubber roll running against it.

When running two side wet waxing on a dip squeeze waxer the sheet is dipped in the wax bath before passing through the metering rolls.

The conditions of operation of a dip squeeze waxer controlling the amount of wax applied, the amount of penetration, the surface wax and gloss are:

Wax and water temperature. Temperature of wax and water must be thermostatically controlled within a very few degrees. Variations in wax temperature will cause a change in viscosity which can effect the amount deposited on the paper. Water temperature control is required to obtain uniform chilling and gloss.

Dwell of paper in water. When sheet is dipped in wax bath, it is usually done by running paper under an adjustable dip roll which is mounted on a rack and pinion. The depth of dip in the wax affects the degree of penetration into the sheet.

Rubber roll hardness. This is another factor determining the amount of wax on the sheet and the degree of penetration. The softer the rubber roll covering, the more wax it will normally apply. Several hardnesses of rolls are required to run the usual range of wax coatings. These hardnesses will range between 10 and 50 P. & J. Plastometer (⅛" ball).

Nip pressure. After proper rubber roll hardness has been determined, additional control over wax film is obtained by control of pressure on the rubber roll. This is done pneumatically or hydraulically, with gauges measuring pressure used.

Machine speed. The faster a dip squeeze waxer operates, the more wax it applies. Machine and sheet speeds must be controlled, therefore, for uniform wax application. Visual and recording tachometers aid the operator in controlling machine speed. Constant tension on expiring and rewinding mill rolls guarantee the maintenance of any set speed.

After all machine conditions are established to arrive at the desired end product, it becomes obvious that the sheet must remain relatively uniform for production of a good wet waxed paper.

These general requirements seem to qualify raw stocks as good surfaces for wet waxing:

1. Uniform caliper and basis weight across width of sheet.
2. Fiber well laid down. Fluffy fibers will wick moisture.
3. Good wax hold out characteristics to aid in surface wax control.

4. Good smoothness, as sheet smoothness is reflected in waxed surface smoothness.

5. Uniform moisture content, which has strong bearing on waxed sheet softness and wrapability on packaging machine.

Heat Sealing Wet Waxed

Heat sealing wet waxed papers have many large volume uses. The principal ones are wrappers requiring an easily made thermoplastic seal such as for bread, rolls, cartons of crackers, cereals, cookies, gelatin, dried fruits and vegetables, tobacco, cigarettes, marshmallows, butter, and bar wrappers for soap and candy.

These sheets are made both M.F. and M.G. of sulphite or kraft furnishes and finish as both opaque and transparent self sealers. The opaque sheets are both beater filled and coated and the opacity enhances the appearance of the design. The high finish of the Yankee sheet is a fine surface on which to print.

Opaque wax papers are produced on the dip squeeze waxer. Enough wax is applied and held on surface to produce good film with as much gloss as possible. Quick chilling of the wax film creates gloss by the formation of fine needle-like crystals which reflect light.

Transparent papers are unfilled sheets, either sulphite or kraft, generally supercalendered, either glassine type, which will hold wax on the surface, or more absorbent stocks which are soaked in molten wax to improve transparency. After saturation, they are run over a dip squeeze waxer on which the cooling is done by drums. Much slower cooling of this wax film is required to maintain transparency. Slower cooling will form large plate crystals, which are more transparent than those described under quick chilling for gloss development.

Waxed One Side

Waxed one side papers may have a high percentage of the wax in the sheet with just a light film on the surface or the reverse, with just sufficient penetration for good anchorage with a heavy percentage of the wax on the surface.

These papers are used for inner liners, locker papers, and carton overwraps where it is desirable to have the outside surface free of wax using the wax on the one side of the sheet for both protection and self sealing.

Practically all types of waxing stocks are used in the manufacturing of waxed one side papers, both M.F. and M.G. sulphite and kraft sheets. The basis weight range will generally be from 25 to 85 lb.—24 x 36-500.

The waxes used for this type of barrier will generally be those having good flexibility, sealing strength, dead fold and M.V.P.

In the case of the one side waxed locker papers, it is again important that good stripping qualities are incorporated.

A Mayer type wax machine is usually used to construct these papers because of the importance of control of the degree of penetration or surface wax. Immediately after the paper has passed over the wax application roll, its direction is reversed on the machine by passing over a drum type roller. This can be either heated or chilled, by the injection of steam or refrigerated water. By heating, the desired amount of wax can be driven into the sheet and by chilling quickly the wax is set, which in turn can control the degree of penetration.

Wax Laminated

Wax laminations can be made between two papers of similar characteristics and basis weight or papers of two basis weights having different physical properties. They may also be combinations of paper and foil or paper and film. They may be dry or unwaxed on both outer surfaces, or waxed one side or two sides.

With the use of the two-pan Mayer machine, it is possible to laminate and wax one side or make a three-sheet lamination in one pass through the machine.

It is usually desirable to use waxes or wax blends having good adhesiveness, softness imparting dead fold, and good M.V.P. developing properties. Sometimes it is necessary to use additives to increase the sealing strength of the wax blend.

Wax laminated papers are generally used when better than average moisture vapor proofness is needed, such as glue sealed wrappers for soap, as the stock for forming pounches for dried fruit and gelatins, as a box or carton liner, and as the material for bags for food products.

When combining two sheets of different densities, it is advantageous to apply the adhesive wax to the sheet having the better wax hold out characteristics. This will assure maximum benefit of the adhesiveness of the wax laminant.

Waxed Papers for Special Uses

This covers in a very general way the most common types of waxed paper. In addition to these, there are many sheets tailor-made for special end uses. In some cases both the raw stock and the wax coating contain mold-inhibitors. In some cases special plasticizing is done. In the wax blends of high viscosity the application temperature is frequently above the safe temperature to carry paraffin and micro waxes without the danger of oxidation. Oxidation will create undesirable odors which must be avoided in the manufacturing of food wrappers. In these blends, it is then necessary to incorporate an acceptable antioxidant.

Testing

When these papers are manufactured, there are a number of simple control tests which are run by both the machine operators and the control testers, who operate twenty-four hours a day. Waxed and de-waxed basis weights, raw stock and waxed paper moisture content and gloss are checked on practicall every mill roll.

The majority of the common waxes used are handled in bulk form in tank cars. This is a decided advantage over the old method of shipping in slab, both from the cleanliness and ease of handling standpoints.

When the tank car is loaded at the refinery, a sample of the wax is airmailed to the laboratory of the consumer. This provides sufficient time to make complete tests before the arrival of the car. As soon as the car arrives, an additional sample is obtained as a re-check on the load sample.

The waxes are tested for drop melting point, color, odor, taste, sealing strength, blocking temperature, staining and hardness. Because of the absence of uniform testing procedures for both the waxes and the waxed paper, each manufacturer has devised his own measurements of quality. Obviously this creates a confused picture for the manufacturers of wax, waxed paper and their customers.

The Non-Fibrous Testing Committee of T.A.P.P.I. is working jointly with an A.S.T.M. committee for the development of uniform testing procedures and equipment. This work has been going on for approximately four years. Considerable progress has been made.

As was said in the beginning of this paper, the waxed paper business started in about 1864 and many changes have been made during this time in waxing materials and techniques. A high percentage of these changes have been implemented in the past ten years. Certainly the next ten years will bring about even more revolutionary machine designs, improved materials and control procedures.

Converting of Parchment And Greaseproof Papers

Marshall Rutz

Superintendent of Manufacturing
Kalamazoo Vegetable Parchment Co.

The grease-resistant, high wet strength material formed by the modification of a sheet of special paper by means of H_2SO_4 is called vegetable parchment. It was invented approximately one hundred years ago and was called parchment because it closely resembled parchment made from hides of animals. This invention around 1850 by an English chemist, W. E. Gaine, is said to have been made when he accidentally dropped a rag paper into suphuric acid and quickly washed it with water. Manufacture of this new paper in the United States started in 1885. The name vegetable parchment is used to indicate its manufacture from vegetable fibers. In the early days of vegetable parchment manufacture, much importance was attached to the fact that this new paper did not putrefy under wet conditions as did animal parchment (protein).

Parchment Uses

Today, by far the largest use for vegetable parchment is in the packaging of food products. It is most familiar to everyone as the wrapper around butter or oleomargarine which comes directly in contact with the greasy product. In the food industry, genuine vegetable parchment is the ideal material for the packaging of butter, lard, vegetable shortening, oleomargarine, fresh, frozen and treated meats fish, poultry, cheese, ice cream and other similar moist or greasy products. For canned meats and fish, parchment is used as a liner to prevent discoloration and contamination of the food. It is used as gaskets for milk and cream cans, for milk bottle hoods and as label sheets for bulk ice cream.

Marshall Rutz, superintendent of manufacturing at the Kalamazoo Vegetable Co. graduated from Kalamazoo College in 1934 and obtained his M.S. degree in chemistry from the same school in 1935. In 1937 he obtained his masters degree in chemical engineering from the University of Michigan.

He started at KVP in 1937 in their research laboratory and worked there eight years. Subsequently worked in manufacturing departments as superintendent of parchmentizing machine room, as parchment division superintendent and then as superintendent of manufacturing.

Meat markets use parchment as a "slap sheet" or as in interleaving sheet between slices of liver, etc. They also use it to wrap poultry giblets for placement inside the cavity of the bird. Parchment is widely used in the vegetable markets to wrap or band celery, broccoli, onions, etc. There are many industrial uses for parchment, such as in the wool industry in the spinning process, in the rubber industry as an interleaving sheet and in the steel industry as metal parts wraps. It is also widely used in the food industry as box liners for greasy products such as doughnuts and cookies, printed inserts in ready-mixed cake packages and coffee cans, cheese wrappers, tamale and corn-on-the-cob wrappers, and others too numerous to mention. Parchment is also popular as a tracing paper, greeting card material and as a base stock in the duplicating field (Ozalid).

Parchment Properties

A study of these uses indicates that vegetable parchment has many curious properties in comparison with ordinary paper. It is grease-resistant in lighter basis weights (27 lb.—24 x 36—500), and grease-proof in heavier basis weights. It will not disintegrate in water. This is true even when it is boiled for hours. It has high wet strength. This is normally between fifty and sixty percent of the dry strength. Parchment is completely odorless and tasteless. In the lighter basis weights, parchment allows air passage (important in wrapping fresh vegetables). In heavier weights it is nonporous.

Vegetable parchment is free of loose fibers and therefore is useful where lint is a problem. It is impervious to many chemicals and therefore is useful as a dialyzing membrane.

Vegetable parchment is normally produced in standard basis weights of 27, 35 and 45 lb. (24x36—500). There are many special grades for special uses made in a range of weights varying from 18 lb. (24x36—500) to 120 lb. (24x36—500). Many of these are tailor-made to fit a particular end use. An example of this is the 70 lb sheet made for the packing

of shortening in corrugated containers for the bakery trade. This sheet was made to have the pliability necessary to form a bag to be placed in a corrugated fiber box and to withstand handling in shipment without rupture. It also had to be perfectly greaseproof to prevent the box from becoming grease-soaked. This type of package holds 50 pounds of shortening and replaces the familiar large round metal pails.

While the color of parchment is usually white, it can be made in a variety of colors.

Vegetable parchment is produced by four paper mills in the United States and two in Canada. The capacity of the United States machines is approximately 37,000 tons per year.

The base stock for vegetable parchment is called "waterleaf". This paper is made from specially selected chemical wood fiber. It is extremely absorbent to water and solutions because it is unsized. Blotting papers and filter papers are examples of a waterleaf type of paper. Extreme care must be exercised in the manufacture of the waterleaf to be certain that no foreign substances such as waxes, oils or any other material that will reduce the absorbency is present.

The selection of beater dyes to tint or color the waterleaf is an interesting one, since the colors must be acid proof as well as proof against any chemicals with which they may come into contact in actual market use.

Parchmentizing

A parchmentizing machine consists of four major sections: the acid dip, the acid recovery system, the washer section and the dryer section. It is merely a means of treating a continuous web with sulphuric acid, washing and drying it. Exclusive of the waterleaf, the results obtained by parchmentizing are affected by the length of time in the acid and by the strength of the acid. The length of time in the acid varies widely, depending upon the type of sheet it is desired to produce. By various combinations of time and concentration, the manufacturer can produce almost any quality in the sheet desired by the market. The sheet is held in the acid dip by means of rubber covered or copper tubes and the excess acid is expressed off the web by means of a rubber covered press section.

The paper continues into acid recovery vats, each equipped with similar presses. These vats have a small flow of water through them so as to dilute the acid in the web and yet provide a sufficiently strong diluted acid to make it economically possible to concentrate it for the re-use of the acid. The recovered acid, after adjustment to proper strength, is reused in the initial acid vat. Parchment machines are made with such an efficient closed system that the sulphuric acid make-up requirements are very small.

Upon leaving the acid recovery system, the web is led into the washing section which removes the last traces of sulphuric acid. Some of the heavier grades receive a neutralizing treatment with ammonia to speed up the washing process. The paper, after leaving the last press of the washer section, is led over conventional paper machine dryers and wound up on a reel. Special sizings, such as starch, glycerine, sodium benzoate, sodium propionate, etc., may be applied to the sheet by means of an ordinary size tub. Regular vegetable parchment is wound up on the reel as a pure cellulose web. This purity is a quality which makes regular parchment highly desirable. Departure from the pure sheet is dictated by particular and unusual end uses. Other sizings which are put on parchment can give it mold-inhibiting, anti-rancidity, anti-oil creep properties, as well as releasing qualities toward crude rubber and adhesive masses.

The waterleaf sheet quickly reacts with the proper strength of sulfuric acid to form a substance called amyloid, a jelly-like mass. This amyloid is somewhat soluble in the acid and unless the reaction is quickly stopped, complete dissolution of the cellulose will result. The amyloid as it initially forms around each individual fiber in a sheet of waterleaf which has been dipped in the acid is sticky and therefore welds the entire web into a single film. Quick dilution of the acid stops the amyloid-forming action and pure cellulose is again formed. The cellulose has been changed physically, not chemically, since analysis has indicated that parchment has the same chemical formula as cellulose. All traces of the acid are washed out by large volumes of pure water. The resultant sheet is as pure a cellulose as the waterleaf from which it was made.

As can be appreciated, the corrosion problems connected with the manufacture of parchment are great. Only materials resistant to sulphuric acid such as lead, glass, rubber and certain stainless steels can be used. The operators of the equipment usually wear special acid-proof clothing and are supplied with arm-length rubber gloves to allow them to thread the paper through the acid and washers.

The basic crew on a machine consists of a washerman and a dryerman. Maximum web width possible on existing machines is 100 inches. Any size less than this is readily obtained by setting into the machine a waterleaf roll of narrower width or by taking a trim as the waterleaf roll is unwinding It is desirable to trim before parchmentizing because the final product cannot be re-worked. Waste parchment must either be burned or shredded as excelsior, while the waterleaf can be easily reclaimed. There is considerable demand for shredded parchment for use as a packing material. Its freedom from lint and its resiliency make it ideal for packing delicate instruments and other fragile products. When parchment accidentally gets into a beater, the entire load is usually dumped to the sewer because of the inability of the beater to de-fiber the parchment.

Chemical Additions and Treatments

Several hundred types of vegetable parchment are produced, dependent upon the end use. As mentioned above, chemical sizings can be put on the sheet. It can be plasticized so that it is as soft as a rag by means of hygroscopic substances such as glycerine.

Parchment is waxed when necessary to give it resistance to moisture vapor transmission. This is accomplished in an ordinary waxing machine as either a one-side or two-side application. The principal uses for waxed parchment are as fish wrappers and bags for sausage.

A popular parchment item with the dairy trade is one which is semi-parchmentized and then lightly waxed. Parchmentizing is controlled so that the parchment is slightly wax absorbent and then enough wax is applied to saturate the sheet, but not leave any surface wax. The wax contributes a measure of resistance to water transmission and aids in the workability of the paper on the butter-wrapping machine.

Parchment can be creped either on the parchmentizing machines or as a subsequent off-machine operation. In the latter case, the parchment is thoroughly re-wetted and expanded before being subjected to the action of the press and creping blade. The product has remarkable strength and is ideally suited for barrel lining and heading when wet and greasy materials are being packed. It is also a wrapping material for beef and veal carcasses in packing houses.

Opaque parchments are made by adding titanium filler to the beaters. This filler is unaffected by the parchmentizing process and enhances the appearance of the parchment. Unfilled parchment, when wet, is very transparent in contrast to opaque parchment. The dry opacity of 35 lb. parchment may be increased from 45 to 65 (Bausch & Lomb). Wet opacity may be increased from 25 to 55 (B. & L.).

Another grade of parchment is made from semi-bleached kraft. Unless it is specially colored, this normally has the brown color commonly associated with unbleached kraft. This grade of parchment is produced in a manner similar to the normal fully bleached grade, and has similar properties, except for increased burst and tear. This increase is 10 to 15 per cent on the burst and 15 to 20 percent on the tear.

Parchmentized unbleached kraft is primarily used in the bulk packing of fruits and vegetables, although there are numerous industrial uses where the strength of the unbleached kraft is more important than the color.

Testing

The physical testing of parchment paper is identical with that of normal papers, except for the additional testing for wet burst and grease-resistance. The test for wet burst is made after the sheet has soaked in water for a few minutes. The ratio of wet burst to dry burst is of some value in the control of the parchmentizing process.

There are two methods of testing for grease-resistance. One is the TAPPI Turpentine Test for Greaseproofness of Paper, No. T454, which makes use of a small pile of sand placed on the sheet to be tested and then saturated with red colored turpentine. The length of time for a stain to show on a white sheet of paper under the sample is taken as a measure of the grease resistance. The other method makes use of the actual greasy material to be packaged and subjecting the combination both to accelerated tests and to prolonged tests under conditions which would normally prevail when the product is in use. The latter is preferred if time is available.

A singular and many times troublesome property of parchment is that it will expand more than seven per cent when wet with water. Exposure of the sheet to moist air causes more expansion than shown by normal papers and this must be kept in mind during subsequent converting operations. Parchment is manufactured at 5.5 to 6 per cent moisture content, which is approximately in equilibrium with 45 to 50 percent relative humidity. It is quite important that storage conditions be held as closely as possible to this figure or difficulties will be encountered. In press rooms, especially, humidity control is important if registration, curl and other troubles are not to be encountered. Parchment's quick response to moisture can be demonstrated by placing a small piece in the palm of the hand and noting its tendency toward rapid curl.

Printing

All of the printing methods are used in the printing of parchment, but letterpress is perhaps the one most widely used. Both metal and rubber plates can be employed. There is a definite tendency for the hard surface of the parchment to considerably shorten the plate life.

Ink suppliers have done an excellent job in perfecting inks which will print on parchment and still pass very rigorous laboratory and use tests. Printed oleo and butter wrappers, for instance, are made to withstand soaking for days in salt water, tap and distilled water, lactic acid, chloramine T, and other chemicals, as well as several hours in some of these at 212° F. In none of these solutions should the ink rub off, change color, or cause discoloration (bleed). The inks must pass, of course, actual package tests on the product, in addition to the accelerated tests. The drying of the ink must be dependent upon the evaporation of solvent or the oxidation of a varnish, since parchment is non-absorbent toward oils.

The rewinding, sheeting and trimming of parchment does not differ radically from the normal procedures with ordinary papers. Approximately one-half of parchment production is shipped as rolls, either printed or plain. The balance is in sheets.

Parchment can be laminated to board, foil or other parchment and paper by means of waxes or other adhesives. During the last war paper motor oil containers lined with parchment displaced metal cans because of the metal shortage. Because of its ability to strip clean from butter and margarine, parchment laminated to aluminum foil is in wide use as an attractive wrapper. Generally speaking, laminated parchment is useful wherever the peculiar properties of a parchment surface can be combined with the properties of a backing stock for a particular end use.

Greaseproof Paper

A paper in the same general classification as vegetable parchment is one known as "greaseproof." Both of these sheets are peculiar to the paper world because they have been made grease resistant by means other than coating or impregnation with greaseproofing materials. Grease-resistance is an inherent property of vegetable parchment and "greaseproof." The uses for "greaseproof" are primarily in the baking industry, although much is used in the chemical, cosmetic, medicinal and metal goods industries. When waxed or coated with moisture-vapor-proof barrier materials it is used as wrappers for candy, dehydrated foods, frozen foods, potato chips, cheese, coffee, crackers, cereals, etc.

"Greaseproof" is manufactured on the paper machine from highly hydrated pulp. Special spruce pulps made by the sulphite process are most popular as the starting material, but some kraft pulp is used. Hydration is accomplished by long beater action, many times longer than for ordinary papers. Due to the hours of mechanical action, the pulp takes on a gelatinous form and is then passed over the fourdrinier wire. The water drains from this pulp very slowly and an extra long wire is necessary and because of the denseness of the sheet, it must be dried slowly. The resultant paper is called "greaseproof." In this form it is also the base stock for the manufacture of glassine. To produce glassine, the "greaseproof" is dampened and supercalendered through a heated stack under high pressure. The action of the calender causes a further densification of the sheet, as well as a change from translucency to high transparency.

Development of resins such as urea-formaldehyde and melamine has made it possible to manufacture greaseproof with wet strength qualities. Wet strength "greaseproof" is therefore competitive with vegetable parchment wherever the wet strength chemicals are able to withstand the action of the material to be packaged. In addition to wet strength, "greaseproof" can be given opacity by means of pigments added to the beaters and can be produced in a wide variety of colors. It is made neutral for special non-corrosive packaging uses. By means of tub sizing, it can be plasticized and given treatments to retard mold growth and prevent rancidity. "Greaseproof" is also produced in laminated form as "greaseproof" to "greaseproof," "greaseproof" to foil, "greaseproof" to synthetic film or "greaseproof" to board. It is also coated with wax, as well as with many solvent coatings.

The further conversion and testing of greaseproof paper very nearly parallels that of vegetable parchment, and it would be superfluous to repeat the points previously covered.

The manufacture of vegetable parchment and "greaseproof" represents a very small section of the total paper and paper board industry. It is small in comparison because for the majority of uses of paper there is little need for grease-resistance or wet strength or a combination of these two properties. Then, too, the added conversion makes these papers cost more than ordinary sheets. These industries, however, fill a very definite need in the paper industry.

Some Tangential Considerations In the Production of Liquid-Tight Containers

Ernest Reed

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This chapter has to do with the fabrication of paper and the converting of various paper products into containers which will be ultimately used in packaging foods. Let us consider specifically the liquid-tight container. This type of container will be found in the market containing foods which are wet, in contrast to containers which may have in them dry foods, such as shredded wheat biscuits, oat meal, rice, starch, etc. Because the liquid-tight containers must, in the first place, be designed to contain wet foods, they must meet certain specifications from the point of view of form and structure, but we are not concerned with those specifications in this chapter. From another point of view the liquid-tight container must be so fabricated that when it ultimately contains a wet food, this container must not have in it ingredients which will be harmful in human consumption, because if such harmful substances are in, or on, the container, they have a good chance of getting into any wet food such as milk, cream, oysters, cottage cheese, etc. The harmful substances may be of two kinds. They may consist of bacteria or other fungi, or they may consist of chemical substances.

Considering first the organisms, there are many different living organisms which occur in mill systems and therefore may be of importance in the fabrication of the liquid-tight container. Of these organisms, in one collection, 32 are bacteria, 1 ascomycete, no basidiomycetes, 2 phycomycetes, 14 fungi imperfecti, 3 algae, and occasionally a protozoan has been observed. Those bacteria which are human pathogenic forms normally do not occur in the

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processes of the mill system but they may get into the system through polluted water. Because of this possibility, mill technicians should be testing for their presence as a safety measure. These forms of bacteria may also get onto the finished product when the containers are stored or handled in unsanitary conditions. This becomes a problem for the user of the container such as the restaurant man or the ones packaging salads or cheese in these containers.

The many organisms which occur in the mill system are of importance as follows:

1. Some of them are the cause of slime formations and therefore the responsible agents for costly shut-downs in mill operations.
2. Some are causal agents in felt deterioration, etc.
3. Some are the cause of odors developing in the paper and these odors are of course costly when occurring in packages containing food.
4. Their build-up in the system also necessitates the use of costly germicides which in turn accentuates the odor problem.
5. Some cause discolorations of the paper.

It is, therefore, important that paper mill operators be constantly aware of the problems created by microorganisms. A build-up of these organisms might occur in various places in the mill system. Some of the most important of these places are: mill influent waters; white waters; calender stack solutions; and storage, dump or cycling chests.

Technicians in the plant should be able to test at these particular spots frequently in order to keep a check on the frequency of occurrence of the organisms and in general what types of organisms they are.

The significance of the different organisms in the build-up of slime is still being studied and so from this point of view, the colonies of organisms as a whole is considered at the present time, rather than specific forms. This is also true of the organisms when considered from the point of view of whether or not they are the cause of certain odors. This study is underway

so the present position is that some odors are produced by the microorganisms and therefore the microorganisms must be eliminated.

Microorganisms are introduced into the mill system with the water and with the raw materials. When virgin stock alone is used as the raw material, there is very little introduction of microorganisms, but as soon as any form of scrap is introduced, then there is the possibility and the probability of the introduction of microorganisms. In any process involving water and organic materials under ordinary conditions of a laboratory or mill, there is a tendency for microorganisms to get started. The best and most efficient control which will prevent the accumulation of microorganic forms is thorough sanitation. Surfaces which are rough and pitted with holes and cracks result in their being difficult to clean thoroughly. Even though the surface be of the best in being smooth and easily cleaned, still those responsible need to be deeply interested in *removing* from the surfaces accumulations of scum, because these are colonies of microorganisms. Sufficient force must be behind the water used in cleaning. Adequate mechanical devices must be at hand to remove these formations of scum.

There are certain chemical agents which are deadly to microorganisms. These are generally classified as germicides and basically they consist of three groups known as phenols, mercurials or chlorines. Many mills use germicides in various locations of the mill in order to kill or control the microorganisms. For this, proper chlorination is adequate but there are occasions when stronger germicides are more helpful. If the mercurial type germicides are used in mills making food container board, they should be thoroughly washed out of the system after the cleaning process so that the germicide does not get into the mill system, because when it does, it has a possibility of getting onto, or into, the paper. The germicides have been so carelessly accepted that they have been considered a cure-all for slime control and this has had its undesirable results. When too much germicide is used, it gets onto the paper and is a cause of odors in the paper and it also provides a poisonous substance in and on the paper, which may be transmitted to the food in the ultimate container. Not enough consideration has been given to the acidity of the medium at the point of application of the germicide. If the acidity is not optimum, the germicide may precipitate out and thus no longer function as a germicide in the mill system. In order to function in killing the organisms in the system, which it is used for, the germicide must stay in solution. Any germicide which is precipitated out of solution and therefore onto the paper or the lining of the container is not functioning in the mill system, but is only causing further trouble.

Another important factor about organisms is that some of them, in the presence of starch, will result in a pink coloration developing on the paper and it is likely that other colors may also be due to other organisms. So it is important that when different substances are introduced for different purposes, the technician should be on guard for the presence of the organisms which may react under those specific conditions.

Toxic Substances

The primary sources of poisonous substances entering into paper are the germicides that are used in controlling the microorganic life. These can be reduced to the harmless point, or better still eliminated, by good sanitary procedures.

When the paper is converted into liquid-tight containers, there is introduced the adhesive, or glue, and even though the container may be surfaced with a lining of paraffin, chemical ingredients of adhesives may possibly seep out of the adhesive into the contained food. Adhesives are of such a nature in their composition that they require preservatives. These preservatives again are germicides and all germicides by definition are poisonous substances—that is why they are germicides. Certain germicides can not be used in adhesives because of their toxic possibilities in human foods. These same considerations must be given to coatings, inks and dyes, etc.

Inks and dyes seldom are applied in such a manner that they would normally come in contact with the contained food but many of the containers are packaged for shipment and storage nested, so that ink or dye may be transferred from the outside of one container to the inside of another. This requires consideration of the materials which are used in the composition of the inks and dyes.

Odors

Paperboard is considered as having a natural paperboard odor. The attitude behind this expression needs further examination since board manufactured under ideal conditions should be odorless. Virgin stocks, such as pine, or spruce, or hemlock pulp, should be approached with the probability that each virgin stock has its own specific odor. Hemlock, for example, has a very strong odor and a small amount of hemlock introduced into a mixture of other virgin stocks may cause an off-odor in the entire pulp production. So, odor is introduced into the paper container first by the mere nature of the material used. Chemically processed pulp will have chemical odors of various kinds unless thorough washing processes are followed in order to eliminate excessive amounts of chemicals. This leads to the rather startling conclusion that virgin chemically processed papers may have off-odors.

Other odors are introduced by organisms which are allowed to accumulate in the mill system. Others are introduced by germicides that are used in order to keep the organisms in check. Odors may be introduced by inks and dyes. Odors may be introduced in the converting plant by incorrectly heated waxing agents or sizes.

In production processes in general, odors may be due to unsanitary conditions. In mill systems which use scrap, odor sources may be picked up as dirt with the scrap and of course, any materials responsible for odors such as inks, coatings, and waxes in scrap will be passed on with the scrap, but those mill systems which use waste materials from city collections have innumerable sources of odors due to extraneous matters in the waste which can consist of anything imaginable. Therefore, the waste must be carefully sorted in order to reduce the possibility of odors.

Good sanitary control measures in a mill will be good economics and also contribute toward the production of paper which can be used as food containers.

Public Health Inspection

Since paper containers are designed for packaging food for human consumption, consideration must be given to provisions existing for the purpose of protecting the public from organisms and poisonous substances which might possibly be in the food in the container. There are upwards of 15,000 public health officials in the United States. These are various jurisdictions, some being federal, some state, city, county, and other commonwealth organizations. It is the responsibility of this army of public health officials to ascertain with certainty that the public is being protected against health hazards in any form.

The paper container as a package for food has not been considered and is not considered as a serious threat in the field of public health, but never-

Appendix

PLANT INSPECTION REPORT

NAME OF PLANT .....ADDRESS .....

INSPECTION NO. .....DATE.....DATE OF LAST INSPECTION .....

Sir: An inspection of your plant has this day been made and your attention is called to the items marked below with (X).

ITEM NO.

1. *Harmful Substances Prohibited.* (1a) Adulteration of foods—No possibility of foods becoming contaminated wth substances injurious to health ( ), harmful adulterants ( ), questionable materials ( ).....( )

(1b) Packaging materials and containers—free from slime spots ( ), odors ( ), tastes ( ).....( )

2. *Paper and Paperboard.* Made from clean, sanitary, virgin stock only ( ), made at adjacent mill and protected ( ), received wrapped and sealed ( ), outside sheets discarded immediately prior to fabrication ( ).....( )

3. *Adhesives.* Non-poisonous ( ), dried films odorless ( ) and tasteless ( ), do not contaminate food ( ), resistant to decomposition ( ) and leaching ( ), stored, handled and used in sanitary manner ( ).....( )

4. *Moisture-Resistant* Materials. Materials are impervious to liquids ( ), are odorless ( ), tasteless ( ), non-poisonous ( ), do not crack open ( ), slough-off ( ), flake-off ( ), pull away ( ).....( )

5. *Protection from Contamination.* (5a) Surfaces coming in contact with foods—protected at all times from damage ( ) and from exposure to contamination ( ).....( )

(5b) Fabricated products protected during shipping and storage—by well constructed shipping containers ( ), tightly closed ( ), sealed ( ).....( )

6. *Bacteriological Standards.* Free from coliform bacteria ( ), not more than one colony per one sq. centimeter ( ), conforms to bacteriological standards in U.S.P.H.S. Milk Ordinance & Code ( ).....( )

7. *Plant Sanitation.* (7a) Plant surroundings—immediate surroundings clean and sanitary.....( )
(7b) Buildings and rooms—clean ( ), well lighted and ventilated ( ), free from dirt, insects and vermin ( ), devices used for removal of fumes and dust. ( ).....( )

(7c) Water supply—easily accessible ( ), adequate ( ), of safe sanitary quality ( ), no cross connections ( ).....( )

(7d) Floors and corners—kept clean ( ), cuttings handled and baled in sanitary manner ( ), stock protected from contact with floors ( ), floors tight and kept in good repair ( ), accessible for cleaning. ( ).....( )

(7e) Machines and units — accessible for cleaning ( ), are kept clean ( ), maintained and operated without objectionable make-shift devices ( ).....( ) unnecessary overhead structures eliminated .....( )

(7f) Manual handling—products handled mechanically wherever possible.....( )

(7g) Hand-washing facilities—convenient and accessible ( ), warm running water ( ), soap, liquid or powder ( ), individual towels and suitable disposal receptacles ( ), washing signs ( ).....( )

(7h) Toilet facilities—conform to local or State ordinances ( ), clean ( ), ventilated ( ), good repair ( ), free of flies ( ), doors self-closing ( ), no direct opening ( ), no storage ( ), for persons intended ( ).....( )

(7i) Lunching facilities—room suitable for purpose ( ), kept clean and sanitary ( ), prompt disposal of food residues, waste, etc. ( ).....( )

8. *Personnel, Cleanliness and Health.* No person with infectious disease, infection of hands, skin or scalp ( ), wear clean, washable outer garments ( ), hands clean ( ), hair confined by cap or net ( ).....( )

Manager of Plant .....

Inspector .....

theless, it is the desire on the part of every public health official to be assured that no health hazards exist due to food which has been packaged in paper. There have been no specific standards passed through legislation to control or direct this industry. The public health officials do not specify details of manufacture for food containers. Their approach is from a different angle, that when any food is presented to the public it shall be free from poisonous and deleterious substances and shall not be adulterated. This is the underlying principle of the approach of the public health officials, but it is stated in different ways in different cities and communities. The briefest summarizing statement available is probably that made by a few of the states to the effect that a food is adulterated if its container is composed in whole or in part of a poisonous or deleterious substance which may render the contents injurious to health.

A group of public health officials together with representatives of the paper package industry have conferred over a period of years on matters pertaining to food packaging in paper and as a part of their efforts, there was published the "Manual of Sanitation Standards for Certain Products of Paper, Paper Board or Molded Pulp." This manual provides that:

1. The packages must be free from coliform bacteria.

2. The colony counts of other forms of microorganisms must be so low as to indicate that reasonable cleanliness is maintained in the production of the container.

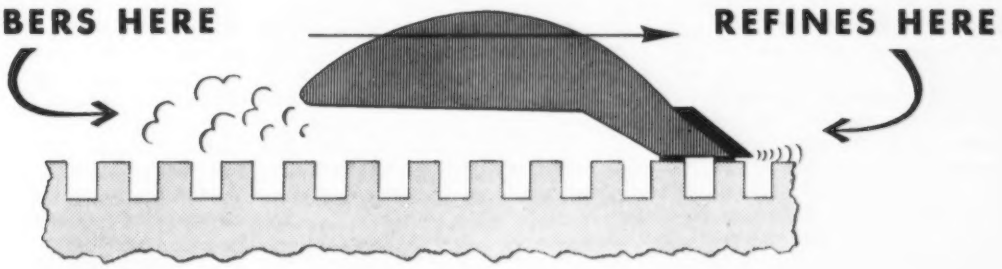
3. There must be no deleterious or poisonous substances in, or on, the container which may be transferred into the contained food.

4. The food must not become adulterated from the package. Under this, off-odors are considered as adulterations, and also off-tastes. These two factors are closely related.

5. All converting plants making food containers, especially for wet foods, should be inspected by an authorized inspector for the purpose of advising the management of the converting plant pertaining to details which are important in achieving good sanitary conditions. These inspections should occur frequently enough so that the public health officials who might be concerned could be assured that such inspections were taking place sufficiently often to insure that good sanitary practice was being followed.

There is another very important angle to these inspections—it has often been noticed that containers fabricated in any of several plants are so clean that there should be no question about the conditions under which they were made and therefore there should not be the need of these inspections as long as the finished product satisfied all requirements. The answer to this is that potential troubles can not always be detected by one untrained in sanitation. The inspector will not only have in mind the conditions under which the containers are currently being made but he will also have in mind what can happen under certain other conditions. That may be illustrated by a well of water which may be highly satisfactory for drinking purposes year in and year out and therefore cause no concern, but an inspector may find that a barn or refuse from human habitats may be so situated that under certain conditions, the water could be greatly contaminated and become a real threat to the people using it.

An outline which is followed as a guide for the inspection of converting plants is provided in the appendix.



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Round Nesting Paper Drinking Cups and Food Containers

Homer N. Calver

Secretary of the Public Health Committee
of the Paper Cup and Container Institute

Homer N. Calver was born in New York City. He is a graduate in Sanitary Engineering, Massachusetts Institute Technology, 1914. At present he is secretary of the Public Health Committee of the Paper Cup & Container Institute since 1934, also Secretary, Public Relations Committee. He is also a member of TAPPI. Formerly Mr. Calver was Executive Secretary of American Public Health Assn., assistant professor of hygiene, New York University Medical College, and director of health exhibits, New York World's Fair. Other connections include:—Captain Sanitary Corps, U. S. Army, World War I; Consultant on Health Education in Institute of Inter-American Affairs, World War II; Vice-President and a founding father of the Public Relations Society of America. Honorary Fellow of the Royal Sanitary Institute of Great Britain; Formerly Editor, American Journal of Public Health; Presently Editor of Health Officer's News Digest.

The paper cup industry owes its beginning in a large measure to the abolition of the common drinking cup. The impetus for this occurred one hot, sticky, July day on a train crossing the Kansas prairies in the year 1907. Since Diesel locomotives and air conditioning were still to be developed, the car windows were open, dust and smoke rolled through the car. Men had their coats off, women were fanning themselves, babies were crying, and throughout the car was the smell of sweat and half-spoiled food. Many of the passengers were on their way West to take the "cure" for tuberculosis. From time to time, between coughing and spitting, they would walk to the water cooler at the end of the car for a drink of water. Here there was a tin cup on the end of a chain. One after the other, as the train rattled through the hot afternoon, the passengers drank from the same common cup.

One passenger sitting near the water cooler was Dr. Samuel J. Crumbine, then secretary and executive officer of the Kansas State Board of Health. As he watched this parade of sick and well, swapping saliva via the tin cup, he decided to wait until the end of the journey before he too tried to slake his thirst.

Later that year, Dr. Crumbine had occasion to take a night trip. He sat for awhile in the smoking room of the Pullman car, talking to two cattlemen returning from Kansas City. The traditional water cooler was in the smoking compartment. But, this being a Pullman car, there was no tin cup on a chain—a heavy glass, never washed, was considered more elegant. One of the cattlemen suddenly rose and took the glass with him into the toilet room. At this the other cattleman laughed heartily and explained to the Doctor that his friend had a venereal disease and needed the glass to hold the injection medicine. When the other man came out of the toilet, he put the glass back in its accustomed place by the water cooler. Shortly thereafter, the conductor of the train, passing through, stopped to get a drink, and picked up the glass. This was too much for the Doctor, who snatched the glass out of the conductor's hand and threw it out the open window.

Dr. Crumbine became convinced that the public drinking cup was one of the most important and continuing means of spreading communicable disease, especially the diseases of the respiratory system, and should, therefore be abolished.

However, he knew that in case of a contest in the courts, he must have more positive evidence that the common drinking cup was really dangerous to the public health. He secured the services of M. A. Barber, Professor of Bacteriology at the University of Kansas, to take swabbings from the lips of the cups on the trains coming from Kansas into the Union Depot at Kansas City, and from cups in use in public schools in Wyandotte County, Kansas. These swabbings were cultured and identifications, classification and numbers of the bacteria and other organisms found were noted. This new information gave the State Board of Health the additional information needed to successfully defend any contest that might be brought against an order to abolish any or all common drinking cups in Kansas.

This paved the way for the following historic resolution and order which was passed by the Kansas State Board of Health on March 30, 1909:

"Whereas, it has been repeatedly demonstrated that the use of what is usually known as the common drinking cup is dangerous, and is an undoubted source of communication of infectious disease, now, therefore, in the interest of public health,

"Be it ruled by the Kansas State Board of Health, that the use of the common drinking cup on railroad trains, in railroad stations, in the public and private schools and the state educational institutions of the State of Kansas, is hereby prohibited from and after September 1, 1909. No person or corporation in charge of or control of any railroad train, or station, or public or private school, or state educational institution, shall furnish any drinking cup for public use, and no person or corporation shall permit on said railroad train, or station, or educational institution, the common use of the drinking cup."

Recently, Doctor Crumbine wrote this event in his autobiography, "Frontier Doctor", when he said: "Looking back down the years, I realize that this first effective official attack on an endless chain of infection, the common drinking cup, was an epoch-making one, for it was the first milestone that led to the almost universal abandonment of that particular channel of disease infection".

Year after year, laws similar to the Kansas order were adopted in other states, and for a time travelers carried with them folding drinking cups made of aluminum. One day a young man from Boston came to call on Dr. Crumbine, and showed him a piece of paper folded in a certain way and asked if it could not serve as a conviently disposable individual drinking cup. Dr. Crumbine agreed that it could. Thereupon, the school teacher gave up teaching and began to manufacture and sell his individual drinking cup. That school teacher is now Chairman of the Board of the Dixie Cup Company.

Thus the paper cup was born and

Mr. Calver demonstrating different types of cups and food containers.

the foundation laid for a great industry.

Dr. Crumbine was one of the first full time health officers in the United States. As years went by, other states, cities and counties appointed trained health officers also, and as the public health movement gathered momentum, there grew a greater and greater demand that the food and drink offered to the public be kept clean from time of production to consumption. Gradually, the cracker barrel gave way to the box of crackers, bread was wrapped, milk was bottled, until today perhaps 80 per cent of our food is bought in packaged form, and much of this packaging is in paper. No one has attempted to estimate what proportion of paper production volume is for health protection, but it is evident that large segments of the paper converting industry owe their growth to public health programs. Paper protects health. Because of this, trees are planted and cut down, and sawed and taken to the mill, made into pulp, paper ard paperboard, which is fashioned and treated and printed and packed and sold, and millions of men and women have employment, stockholders receive a return on their investment, communities grow and prosper, and our standards of public health are high.

Those making a career in the business of paper converting will want to remember this responsibility for public health protection because it means also that the paper products you help to produce must in themselves be clean.

Water Cups

Generally speaking, there are five types of paper water cups. The first is the flat water cup which may be either parallel or taper-sided. Taper-sided cups are generally dry-waxed, while straight-sided cups are usually unwaxed and untreated. Construction differences between the various lines are

a. number, placement and width of seams

b. formation of the lip surface

The wedge shape nested water cup is the second type. Such cups have tapered sides and are nested as they come off the machine, and thus are already opened for use. Wedge shaped cups are usually made from dry waxed paper. Some have an extra fold at the lip for greater lip comfort. The third type of cup is the cone shaped water cup which is fully open ready to use. Some have straight edges, while others are made with rolled rims. The fourth type water cup is the pleated cup which is either dry waxed or wet waxed. It is of one piece construction using no adhesives. The cup gains strength and rigidity from the triple thickness of the pleats as they approach the top of the cup, and from the heaviness of the rim.

Construction differences between lines are

a. width and spacing of pleats

b. type of pleating

c. method of folding or rolling the top rim

d. formation of the base

Some pleated cups have a die impression on the bottom to permit the cup to stand more firmly. The fifth and final type of paper water cup is the two piece cup. These are usually printed with a single color decorative motif. On some cups the bottoms are set in while others lock in, both types being held in place with adhesive. The rims are rolled for maximum rigidity and mouth comfort. Two piece cups, like the pleated cups, may be made from dry waxed stock or may be wet-waxed after manufacture. The size range is from 3 through 5 ounces, with many variations between.

Although these cups are known as water cups, they can be used to serve other cold drinks where the time lapse between filling and emptying is a matter of only a few minutes.

Cold Drink Cups

Where the intended use of paper cups is of longer duration and for a larger serving, as in the case of fruit juices, milk, sodas, a highball or a cocktail, they need to be of sturdier construction. They may need to be used with a holder and the paper may require different treatment. To differentiate these larger cups from water cups, they are commonly referred to as cold drink (or soda) cups.

Three types of cups for cold drinks, in sizes from 6 ounces to 24 ounces, are customarily available. The first is the cone shaped, the second a two piece cup, and the third pleated. Some cone shaped cups have a rounded or flat bottom. Construction of all three types of cups is the same as that for water cups. Cone cups are made from dry waxed paper, but the two piece and pleated cups are almost invariably given a wet wax treatment. The two piece cold drink cups and the waxed pleated cups may be used for take-out service and for this purpose various types of snap-in or snap-over lids are available. Such cups may have a lid seat.

Hot Drink Cups

The serving of hot drinks presents another problem. For that purpose there are specially designed hot drink cups. Of the two types of hot drink cups, one is of two piece construction while the second is molded in one piece. Hot drink cups may be further classified as being equipped with or lacking a handle. The two piece cups

are made of an unwaxed board of the strength needed for service of hot liquids and foods. Sizes start at 6 ounces and go up to 16 ounces. All sizes are available with snap-over or snap-in lids for take-out hot drink service. Hot drink cups are available with or without lid seats. Some manufacturers are currently experimenting with various interior coatings of hot drink cups to reduce their permeability by hot liquids.

Food Service

In addition to being used for serving cold and hot drinks, paper is also used for serving foods. Paper utensils for this purpose may be divided into three categories:

1. Portion cups
2. Creamers, medicine cups, sampling cups, etc.
3. Paper dishes
4. Food containers

Portion Cups

Portion cups, though usually small, may be as large as 5½ ounces. Most manufacturers make them in 12 sizes, beginning with ½ ounce capacity. Construction differences between various lines include:

a. Width and spacing of pleats. Some portion cups are shaped with narrow, even pleats from top to bottom, while in others the pleats are more widely spaced. Still others have triangular-shaped pleats pointed at the base of the cup.

b. Method of rolling or folding rims. There is a "wire-type" (tightly-rolled) rim, a loosely rolled rim, and a pressed rim.

c. Formation of base. While the majority of portion cups are round at the base, there are also octagonal shapes.

Shallow or low-wall types of portion cups are identical to the standard type except in the height of their sidewalls. Known in the trade as the "squat shape," their chief advantage is that the portions served in them appear larger than in conventional cups of comparable size. Low-wall cups are particularly suitable for such foods as butter, jellies, preserves, mustard, and mayonnaise. The standard types are used mainly for side dishes of vegetables, small salads, condiments, and puddings.

Creamers

Medicine cups, creamers and sampling cups are, in effect, only small paper cups (usually less than 3 ounces), either pleated or two piece. Creamers are sometimes provided wtih a seat for a lid, and the medicine cups are graduated on the outside to permit measurement of dosage.

Paper Dishes

Paper dishes, often called sundae dishes, may be cone shaped, in which case they need to be used with a holder, or they may be pleated from a single piece of paper or they may be of two piece construction. In the two latter categories, holders are not necessary although sometimes they are used. Some cone dishes have a wide edge or brim around the top of the cone that sets off the contents of the dish. Cone dishes are always dry-waxed. The other types are usually wet waxed, though some may be found made with a dry wax finish. All three types have ice cream service as their major function.

Food Containers

The next class of products are called food containers. These were originally designed and sold primarily for the short-time packaging of foods, usually moist foods, such as cottage cheese. They are still used extensively for this purpose, and such use is growing. In addition, since the war they have been used increasingly for the serving of food, food freezing, as well as for packaging. In factories, in hospitals, in schools and elsewhere, food containers serve as soup bowls and are used in lieu of plates for serving any kind of food which may be eaten with a spoon or fork without the need for cutting.

There are several different types of food containers. The light duty nested type containers are of two piece construction with a set-in bottom held in place with adhesive. The stock may be dry-waxed before conversion, or the containers may be wet-waxed after conversion—either outside or on both the outside and inside—or they may be plastic coated.

Pleated containers are made in one piece pleated from top to bottom with a tightly rolled or folded rim and heavily waxed for rigidity and to provide resistance to liquids.

Heavy duty nested containers include double wrapped types as well as single wrapped types of comparable (heavy duty) weight. The double wrap and single wrap types are of two piece construction with a set-in bottom. The body stock of the two piece container is a light weight two ply board ranging from .019 to .022 of an inch in thickness. Many containers of this type are unwaxed so as to be suitable for hot foods and liquids. Others are supplied with a heavy waxed coating for cold foods and beverages, and also for the packaging of cheese, butter, etc.

Tight-fitting lids, to be inserted in a groove under the lip or snapped or placed over the lip, are available for all types of food containers. Among the most recent variations in lids is the "window" lid which has a transparent center.

The nesting two piece food containers described so far are constructed of seamed side-walls cut in one piece, plus a set-in bottom. There is, however, another type of nesting two piece container which, though similar in shape and purpose to the others, has side-walls made of convolutely-wound strips of board. The major difference to the eye is a bumper roll top to accommodate slip-over covers. Surfaces are either unwaxed, completely waxed or plastic coated.

Food containers, of all constructions, have infinite variety of size and shape. "Cup-shape, squat, semi-squat, tall, and tubs" give some indication of their physical appearance. Sizes go from three ounce capacity to the ten pound capacity tubs for quantity food packaging and food storage.

No attempt has been made here to describe all the different sizes and shapes of the many different kinds of round nesting paper cups and containers that are made. In general, it can be said that there is a size and type of paper cup or container well adapted to the serving of any kind of beverage, hot or cold, and that there are round, nesting paper containers of size and shape and kind adapted to an enormous variety of uses in the serving and packaging of food.

Manufacturing Processes

Paper used in the manufacture of paper cups and containers is usually either bleached sulphite or bleached kraft, with perhaps more bleached kraft being used nowadays than bleached sulphite. Generally speaking, the basis weight, caliper and other characteristics of the paper used in the various cups and containers is determined by the size of the cups or container and the use to which it is to be put. The water cups and other small cups which have a use-life of only a few seconds usually range in basis weight from 50 to 60 pounds, though the cone-shaped cup basis weight may be as high as 90 or 100 pounds for the larger sizes. For two piece cups, the basis weight may range from 100 to 150 pounds and even up to .055 board for tubs and lids. Pleated cups use paper between 55 and 85 pounds basis weight, and the thickness of these sheets is approximately .005 to .006 of an inch. These are of course approximate figures; each manufacturer has his own specifications, and, as with

other paper products, the heavier the intended use, the heavier the paper must be.

Paper Specifications

For all paper cups and containers, the color of the paper is of the utmost importance. The brighter, cleaner and whiter the cups appear, the more acceptable they are to their users. Color is of extreme importance, not only with white and undecorated cups and containers, but also for those that are imprinted. Bright, clean, white paper helps assure that printing will be bright and clear. The printed color must not be materially lowered by the waxing process which is described below. The surface must be even and smooth so that wax will be evenly distributed and so that it may be printed without difficulty. For pleated products, the paper, of course, must be such that it will not tear in the pleating process. It must have a high degree of stretch so that it can take the severe die operation necessary in pleating these cups and rolling the brim. Two piece cups and containers require paper with special qualities which will permit its forming into a firm and rigid finished cup and yet which will take wax, printing ink and adhesive without difficulty. For some types of cups, particularly hot drink cups, various kinds of sizing, resins and other materials are used, which are nontoxic and which do result in a sheet which can be glued or printed or waxed.

Having selected the paper appropriate for the type of cup or container to be made, blanks of the size and shape needed are cut from sheets or rolls. Where the cup or container is to be printed, this printing may be done before the blanks are cut or on the blanks after they are cut. In special machines, these blanks are then formed into the appropriate shape, the edges rolled or not as the case may be, glued, and, in the case of a two-piece cup, the bottom inserted and set in place.

Waxing

Some cups and containers are wet-waxed, some are dry waxed, and some are not waxed at all. In the wet waxing process, the cup or container, after it has been formed, joined with adhesive, and imprinted, is either immersed in a vat or melted paraffin or sprayed with paraffin and then cooled. This waxing process is affected by a number of things, such as the melting point of the paraffin, the speed of the waxing machine, the temperatures involved, and, of course, by the characteristics and quality of the paper and wax used. The amount of wax left on the paper may be much or little and is determined by the strength needed and character of service required of the product.

In the dry waxing process, paper is impregnated with wax before it is cut and formed. This may be accomplished in a number of ways. In one method, the paper passes through rolls, one of which at least revolves in a bath of wax, and this wax is transferred to the paper web and then is heated with squeeze rolls to force the wax into the fibers of the paper, so that practically no wax is left on the surface and no waxy film is apparent on the stock. In a good dry wax job, wax is not apparent to the eye and almost unapparent to the touch. Dry waxing results in the paper being resistant to water and moisture and permits the sheet to remain bright and clean, not marked or mottled by patches or streaks of wax. Dry waxing the paper also facilitates dispensing of the cups from a dispenser.

Sanitation

The manufacture of round-nesting paper cups and containers should involve as little handling as possible of the product from the time the paper is made until the finished cups are packed in tubes. Since the vast majority of cups and containers are used for the packaging or serving of food and drink for human consumption, it is of the utmost importance that great care be taken to keep these products clean at every step in the process. The chemicals used in the manufacture of paper and the heat of the dryer rolls usually result in the paper being free from all harmful bacteria, even though it is not sterile. In the converting process, it is important that no injurious bacteria be introduced in the product, and that the total bacteria count be not increased by careless handling. For example, the paper being unwound from rolls feeding into the blanking machine should not be allowed to drag on the floor. While it is going through the machine, it should be handled no more than is necessary.

All workers in a paper converting plant should wear clean clothes, wash their hands frequently and especially after visiting the toilet. From beginning to end the product should not be stored on the floor or any place where it may be exposed to dust and dirt.

Since the appeal of health protection is a vital sales argument, the paper cup and container industry has taken steps to assure clean products. It would be disastrous to the paper industry if public confidence that paper is clean should ever be damaged — a disaster which would turn profits into losses and jobs into unemployment. It is of the utmost importance, therefore, to you who plan on entering this industry or who may be in it now to exercise every precaution at all points of the converting process in which you are involved to maintain high standards of cleanliness. Unfortunately, the public does not discriminate, and if the paper products of one manufacturere were found to be dirty, the business of all paper converters would suffer. Not only must personnel be neat and clean and careful, but the work places must be clean and orderly and free from danger of contamination.

Conclusion

Paper cups and containers are no longer merely items for a picnic or party. They have now become an essential and integral part of the food packaging and food and beverage service industries in this country. Ignorance concerning the different types of paper cups and containers and the many different uses for which each is designed is one of the great handicaps the industry has had to overcome. A water cup is not suitable for a highball (especiallv for the slow drinker). It has other defects when used this way in addition to being too small. Cold drink cups which are waxed are not suitable for serviñg hot drinks, since the wax is likely to melt. Hot drink cups can be used for service of cold drinks, but they are more expensive than cold drink cups and they are not economical for that purpose. The tremendous growth of the vending machine industry has opened a vast new market for paper cups. Round, nesting paper cups and containers, some of which have window lids, have opened new markets for packaging meats, salads, and other pre-cooked foods for sale in supermarkets, delicatessens and grocery stores.

Single service paper cups and containers are economical and they go far in protecting the public health. Those of you in the paper converting industry may feel secure that you are in an ever-expanding industry, but never forget that the sanitary protection of the product is necessary to maintain that volume. The public has confidence in our products—it is our duty and responsibility to maintain that confidence.

Acknowledgement

The author wishes to express his appreciation for the assistance and technical review given by Samuel J. Crumbine, M.D., Earl Foster, Sealright Co. Inc., Martin Galbraith, Sutherland Paper Co., and R. L. Clevenger, Lily Tulip Cup Corp.

Manufacture of Business Forms

B. J. Staneslow

Moore Business Forms Inc.

Many persons think of our man-made world as a great mass of stone and steel . . . of power, strength, timeless durability; they claim the wheel as the greatest invention of mankind. That well may be. We certainly can't make ourselves believe, whatever our interests, that the world is made of papier-maché; but we must admit that the invention of paper was a singularly effectual achievement!

From the beginning of his time, man has had a craving for recording himself. It was the advent of paper that made his historical chronologies so accurate that we are able today to chart the course of the world.

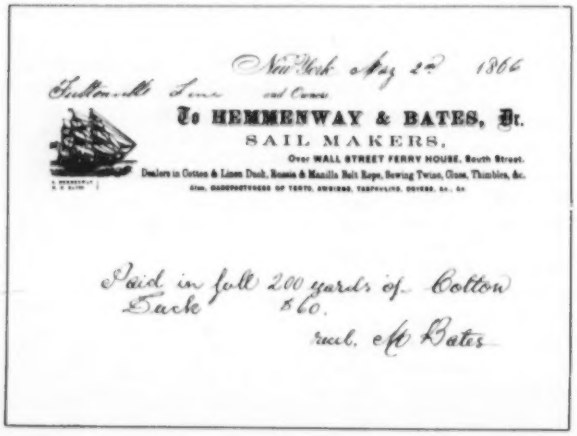
American industry, whatever its nature, operates on paper. This has become such an economic necessity that it has created another great enterprise to service it. This new vocation . . . an offshoot of the printing industry . . . is the manufacture of business forms.

B. J. Staneslow graduated from Cornell University in 1931 with degree of Bachelor of Chemistry; and in 1933, from Cornell University with degree of Master of Chemistry. During his summer of 1930, he worked in the analytical laboratory of Agfa-Ansco Film Corp., Binghamton, N. Y. He was an Analytical Chemist at J. T. Baker Chemical Co., Phillipsburg, N. J., August 1931 to February, 1932; Analytical Chemist at Linde Air Products Co., Buffalo, N. Y., January 1934 to May 1934; Chief Chemist at Moore Business Forms, Research and Service Division, May 1934 to present. He is Coauthor of the paper "Rheology of Carbon Paper Inks" published in American Ink Maker, December, 1950.

Infancy

In its infancy, the business form was a comparatively simple thing: a documentary evidence of things exchanged; substantiation of business done . . . all inscribed by hand. *(Figure 1)* It was with the coming of the machine age and the resultant increased productivity that the business form began to assume its importance in direct management. As demands for products increased, suppliers expanded their facilities; specialization became the keynote. So essential became the matter of record keeping that it threatened to bog down business in a morass of paperwork.

Manufacturing rights to the typewriter were sold to E. Remington and



New York May 22 1866

To HEMMENWAY & BATES, Dr.

SAIL MAKERS,

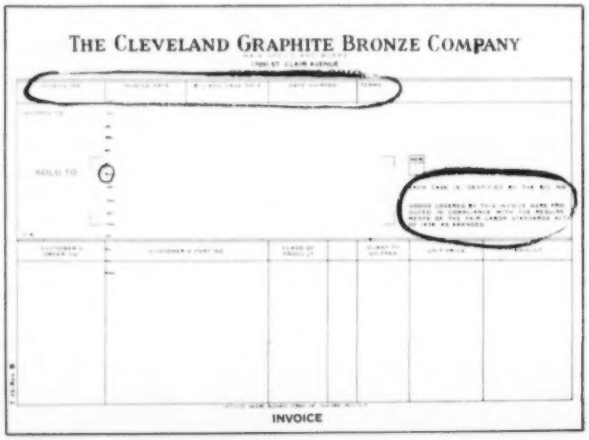
Over WALL STREET FERRY HOUSE, South Street.

Dealers in Cotton & Linen Duck, Russia & Manilla Bolt Rope, Sewing Twine, Clout, Thimbles, &c.

Sold in full 200 yards of Cotton Sacks @ 60.

rec'd. eff Bates

Fig. 1



THE CLEVELAND GRAPHITE BRONZE COMPANY

INVOICE

Fig. 2

THIS IS A PICTURE OF THE

"TYPE WRITER,"

A MACHINE NOW SUPERSEDING THE PEN. IT IS MANUFACTURED BY MESSRS. E. REMINGTON & SONS OF ILION.

IT IS THE SIZE OF A SEWING-MACHINE, AND IS AN ORNAMENT TO AN OFFICE, STUDY, OR SITTING-ROOM.

IT IS WORKED BY KEYS, SIMILAR TO A PIANO, AND WRITES FROM THIRTY TO SIXTY WORDS PER MINUTE—MORE THAN TWICE AS FAST AS THE PEN—IN PLAIN TYPE, JUST LIKE PRINT.

ANY ONE WHO CAN SPELL CAN BEGIN TO WRITE WITH IT, AND AFTER TWO WEEKS' PRACTICE CAN WRITE FASTER THAN WITH THE PEN.

IT IS WORKED WITHOUT EFFORT, AND IS NOT LIABLE TO GET OUT OF ORDER.

IT IS ALWAYS READY FOR USE, DOES NOT SOIL THE HANDS OR FINGERS, AND MAKES NO LITTER.

IT IS CERTAIN TO BECOME AS INDISPENSABLE IN FAMILIES AS THE SEWING-MACHINE.

HUNDREDS HAVE COME INTO USE IN THE LAST FEW MONTHS IN BANKING, INSURANCE, LAW, AND BUSINESS OFFICES, IN THE GOVERNMENT DEPARTMENTS IN WASHINGTON, AND IN PRIVATE FAMILIES, GIVING EVERYWHERE THE HIGHEST SATISFACTION.

EDITORS, AUTHORS, CLERGYMEN, ALL WHO ARE OBLIGED TO OVERCOME THE DRUDGERY OF THE PEN, WILL FIND IN THE "TYPE-WRITER" THE GREATEST POSSIBLE RELIEF.

YOUNG PERSONS ACQUIRE ITS USE WITH WONDERFUL RAPIDITY. IT FASCINATES THEM, AND THERE IS NO BETTER ORNAMENTABLE TO IT FOR TEACHING CHILDREN TO SPELL AND PUNCTUATE.

THERE IS, THEREFORE, NO MORE ACCEPTABLE, INSTRUCTIVE, OR BEAUTIFUL

CHRISTMAS PRESENT

FOR A BOY OR GIRL.

AND THE BENEVOLENT CAN, BY THE GIFT OF A "TYPE-WRITER" TO A POOR, DESERVING YOUNG WOMAN, PUT HER AT ONCE IN THE WAY OF EARNING A GOOD LIVING AS A COPYIST OR CORRESPONDING CLERK.

NO INVENTION HAS OFFERED FOR WOMEN SO BROAD AND EASY AN AVENUE TO PROFITABLE AND SUITABLE EMPLOYMENT AS THE "TYPE-WRITER," AND IT MERITS THE CAREFUL CONSIDERATION OF ALL THOUGHTFUL AND CHARITABLE PERSONS INTERESTED IN THE GENERAL QUESTION OF WORK FOR WOMEN.

MEN AND GIRLS ARE NOW EARNING FROM $10 TO $20 PER WEEK WITH THE "TYPE-WRITER," AND WE CAN AT ONCE SECURE GOOD SITUATIONS FOR ONE HUNDRED EXPERT WRITERS ON IT IN COUNTING ROOMS IN THIS CITY.

THE PUBLIC IS COURTEOUSLY INVITED TO CALL AND INSPECT THE WORKING OF THE MACHINES, AND OBTAIN ALL INFORMATION AT OUR SHOW-ROOMS.

No. 707 Broadway.

LOWER THAN $ RATES.

COPYING WANTED.

CLERGYMEN, BUSINESS MEN, AUTHORS, AND AUTHORESS, WHO HAVE COPYING TO DO, WILL CONSULT THEIR INTERESTS BY RETURNING IT TO US. WE CAN DO IT AT HALF THE PRICE THAT IT CAN BE DONE WITH THE PEN, IN GOOD, CLEAR TYPE, AS PLAIN AS THE PLAINEST PRINT.

WE ARE NOW DOING COPYING FOR ALL THE THEATRES IN THIS CITY.

ADDRESS "COPYING DEPARTMENT," 707 BROADWAY.

AGENTS WANTED.

WE WANT A GOOD LIVE AGENT IN EVERY COUNTY IN THE UNITED STATES TO SELL THE "TYPE-WRITER." IT IS A SAFE, SURE, AND PROFITABLE BUSINESS.

ADDRESS, FOR FULL PARTICULARS,

"TYPE-WRITER,"

No. 707 Broadway.

THE TYPEWRITER WAS NEW AND STRANGE

A four-column advertisement for the Remington in the New York Tribune for December 8, 1875. One of the largest and most compelling advertisements in the papers of that period. (Reduced about one half.)

Fig. 3

Son in 1873, and with the adoption and improvements of this first successful writing machine, came the development of real paperwork methods. Forms were designed to simplify and speed typing; standard information was preprinted to eliminate as much writing as possible. *(Figures 2 and 3)* By 1900, carbon papers were developed to a point where several copies of the same form could be prepared legibly with one writing.

The first adding machine had been patented in 1888. In order to keep all the figures of long lists on one piece of paper, the machine was constructed to use a blank roll of paper threaded through the machine and torn off after each tally. This was an interesting innovation to the forms industry, and they seized upon the idea for handwritten use. They designed a register machine which fed continuous strips of printed forms from rolls across a writing surface, with the necessary carbons feeding from rolls at the side. *(Figure 4)* The carbons remained in place when the forms

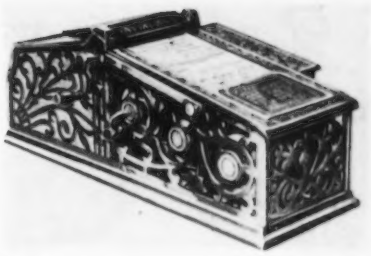


Fig. 4

were withdrawn. This register has been revised and improved as continuous forms printing has developed until it is considered today as the "fastest known method of preparing handwritten business form."

The evolution of the continuous printing and continuous writing of forms has been very rapid these past 40 years. The concurrent and co-operative efforts of paper, forms, and writing machine manufacturers have brought about unparalleled efficiency in the American business scheme. The cumbersome machines of not so many years ago have emerged as the sleek, automatic office appliances of today; forms-writing, the former bottleneck of production, has become a labor-saving installation for rapid volume-recording. *Figure 5* shows the IBM punched card accounting machine.

Business Systems

While these advancements toward the manual speed-up of paperwork were being achieved, the business forms industry was exploring another complex field . . . that of business systems.

Broadly, there are nine key operations that regulate the normal function of industry: buying, receiving, and stocking of the raw materials; processing, selling, and delivering the products made; billing the customer, and collecting his payment; and, finally, disbursing the money due labor and suppliers. *(Figure 6)* The substance of these operations varies with the type of product (or service) and its meth-

Fig. 5

Fig. 6

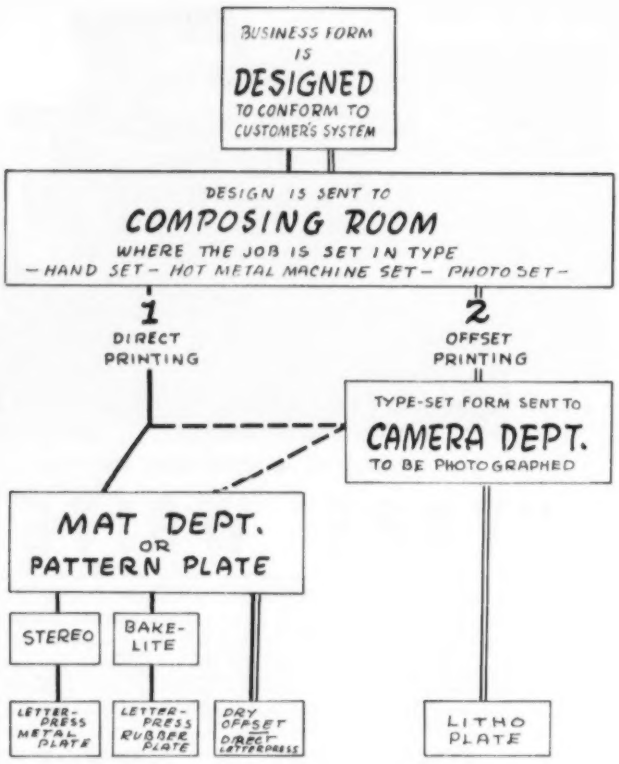


Fig. 7

od of production, hence, the need for an efficient business system. In its simplest form, a system is really an orderly procedure for recording and controlling these various business operations.

Because of the vast scope of American enterprise, forms system-building is a highly specialized job. It not only requires a thorough knowledge of the fundamental principles of the modern art of printing, but an intimate working knowledge of basic accounting operations in a wide variety of vocations; and above all, it requires an intelligent appreciation of the potentialities of both the paper manufacturers and the manufacturers of allied business equipment.

The actual printing of business forms is a complex industry in itself, with all the problems of the printer plus those of the systems engineer. Although changes occur in processes from time to time, the basic principles of printing are employed in the preliminary preparation of a business form as are employed in the preparation of any book or magazine page.

Briefly, after a systems man has created a method of procedure for the user in accord with his proposed system, the designed copy is then sent to the composing room where by any

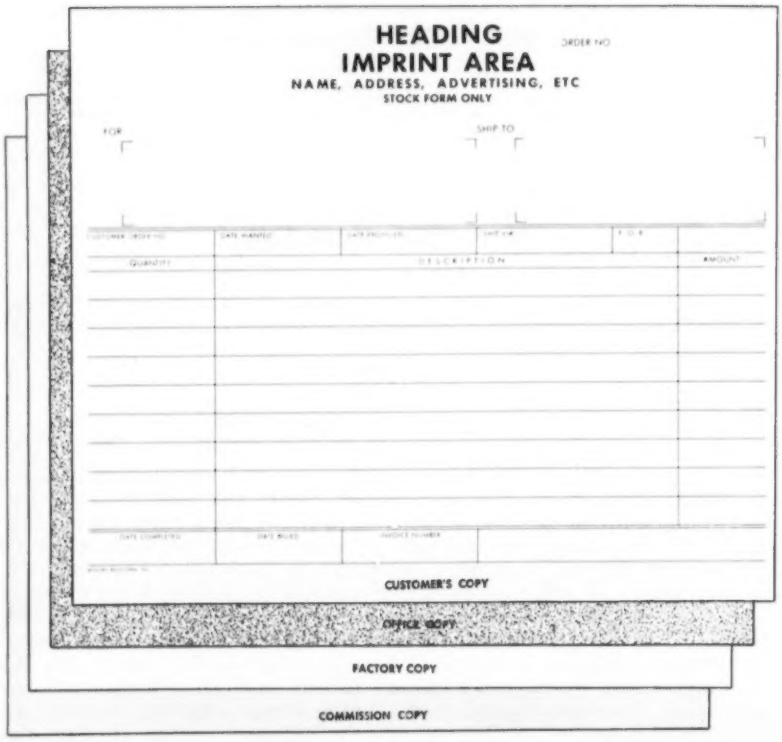


Fig. 8

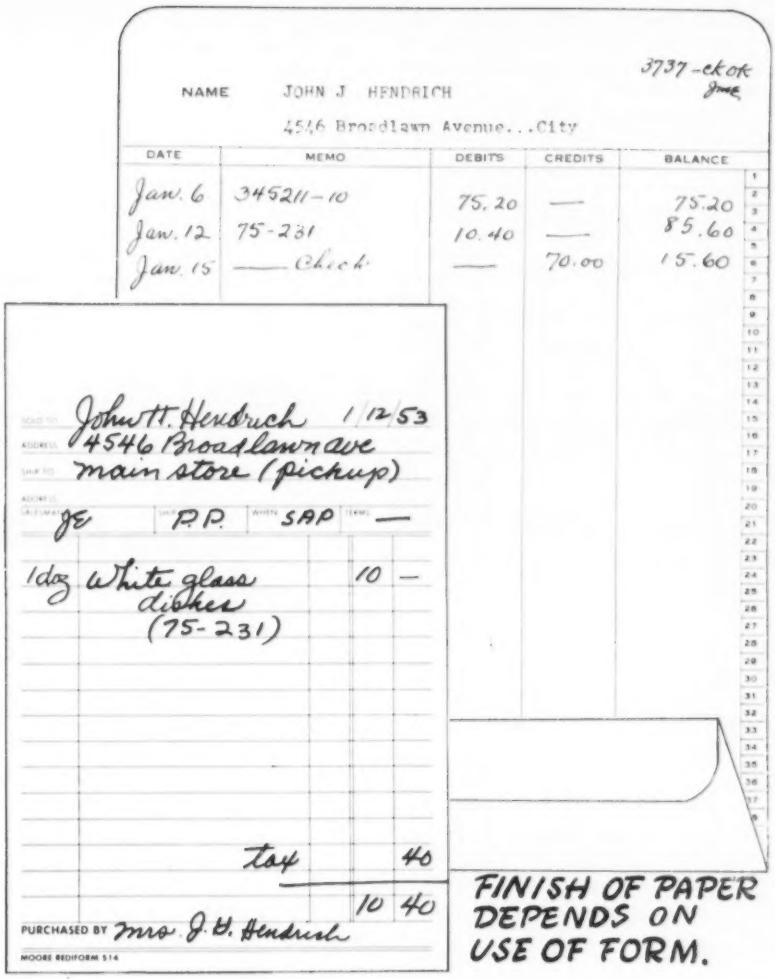


Fig. 9

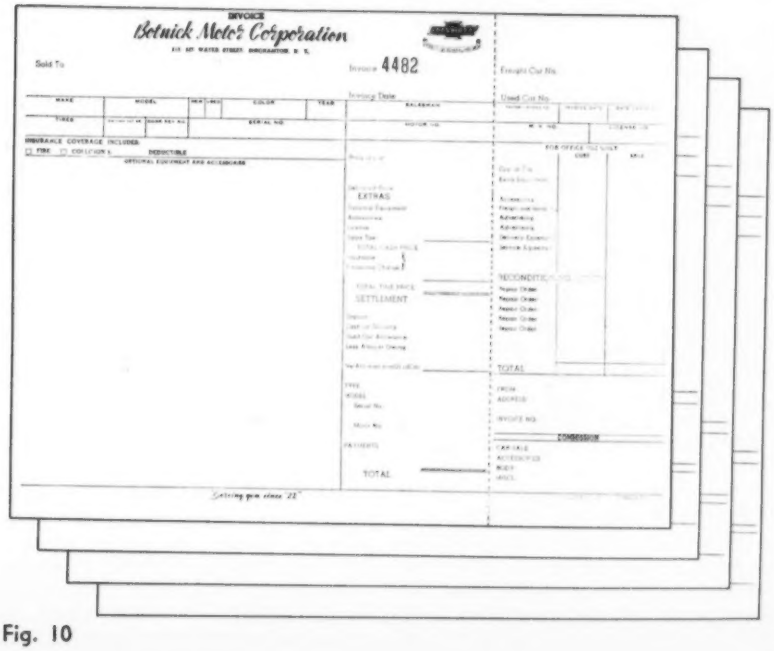


Fig. 10

one of several methods it progresses to the final printing plate. *(Figure 7)* The method selected will depend on the use requirements of the business form and the quality demanded by the buyer.

Selection of Papers

The selection of papers is of primary importance in the manufacturing of business forms, as it materially affects the production, functional use, and selling price of the form. The factory is primarily concerned in obtaining paper in well-wound rolls, free of mechanical defects. This is extremely important for efficient quality production. The paper also must have a good printing surface, with a maximum of opacity, and satisfactory folding, punching, and perforating qualities. The customer, on the other hand, thinks in terms of good appearance, manifolding and erasure qualities, a good writing surface, as well as dimensional accuracy. The control of the moisture content of paper is very important for this latter property. If the moisture content varies from roll to roll beyond specified limits, it becomes impossible to maintain correct registration in each sheet of the printed form or carbon paper and the mechanized forms-writing of today would be impossible.

Permanecy

Then there are the less obvious qualities that enter into the selection of paper. Consider, for example, the permanency of a paper. Many miscellaneous office forms and memos are either temporary or relatively temporary records and can be made from groundwood content pulp compositions or from sulphite, soda, kraft or combinations of these pulps; but some forms, legal documents and insurance policies, which may have to be held in files for 99 years, require much greater permanency and are still made mainly from all rag fibers. As the relative permanency of paper is materially affected by the conditions under which it is stored, this, too, must be taken into consideration by the systems man.

It's probably human to think of industry as our personal "Scrooge" . . . but this Scrooge has heard the chains clanking, too. It is well aware of the fact that the efficiency of an employee depends upon his degree of fatigue; therefore, eye fatigue is one thing the forms manufacturer must minimize when he designs a form-system.

Color

First, the color of paper is important. One-writing, multiple-part systems

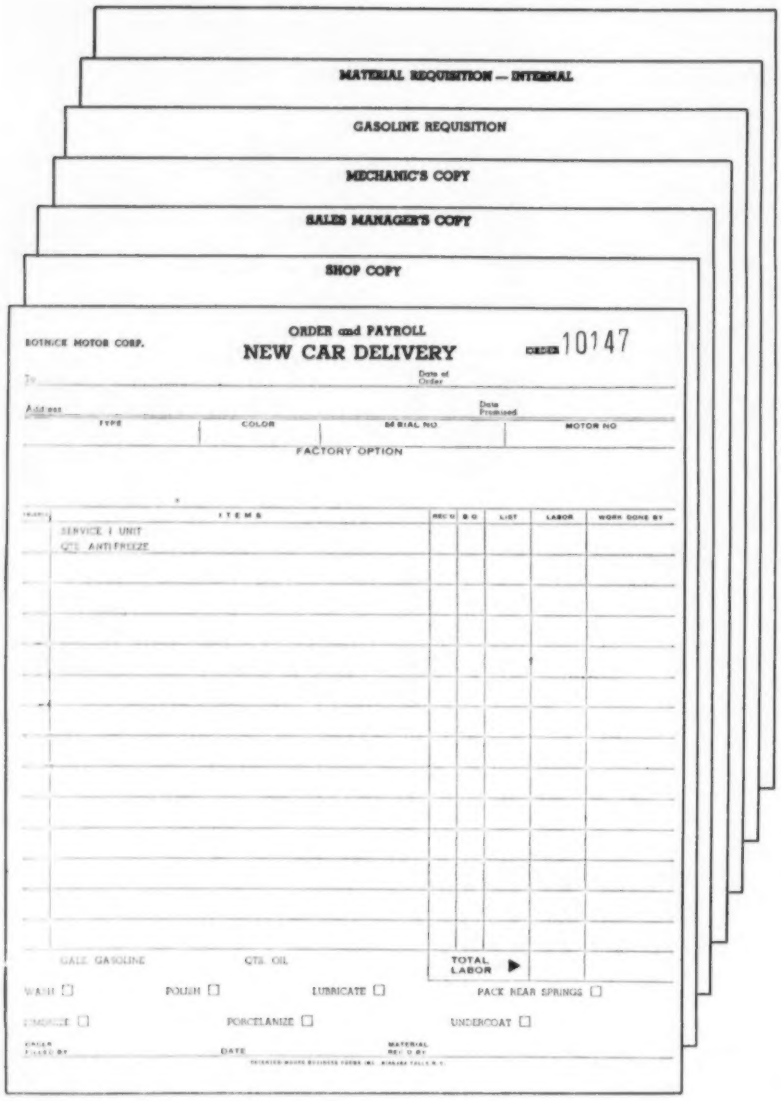


Fig. 11

often require various colors in a set for quick identification and distribution purposes. *(Figure 8)* Cherry and goldenrod are fine signal colors. They are premium-priced papers and are used in departmental work for their attention value. But their brilliancy is extremely hard on the eye and these colors should never be used on forms requiring long or close work. Many firms request "Eye-ease" or "Redi-Read" paper with a slight green tinge for this very reason.

Finish

Scientific study claims that the finish of a paper has as much to do with eye fatigue as the color. Business forms made from a low-finished or moderately calendered paper will be better than those made from highly calendered or super-calendered papers because of the lack of glare. Constant use of high-finished papers can cause as much eye fatigue as brilliantly colored papers.

Here again, the application of the printed form must be considered. A rough-finish paper is fine for pencil-written forms like sales slips, but more permanent records, such as ledgers, are often written in ink and the paper finish should be higher. *(Figure 9)* The final selection of paper finish must be determined by its practical use in the clerical operation rather than by its beauty.

Opacity, Weight and Thickness

Because so many business forms must pass in multiple part over automatic or key-driven writing machines because so many forms must carry terms, conditions, or instructions on the back, and because so many forms must be held indefinitely in office files, the question of opacity, weight, and thickness is one with which the manufacturer of continuous forms must contend.

It is obvious that the thickness of paper will have a lot to do with its opacity, as will the weight of paper. But the thicker or heavier the paper is, the less manifolding qualities it has. Moreover, there are certain situations where the thickness of paper may completely hamper an operation. For instance, if the form is too thick it may jam the writing machine; if it's too thin it may tear or slip out of alignment. In either case, the form will be unsatisfactory and give cause for waste and complaint.

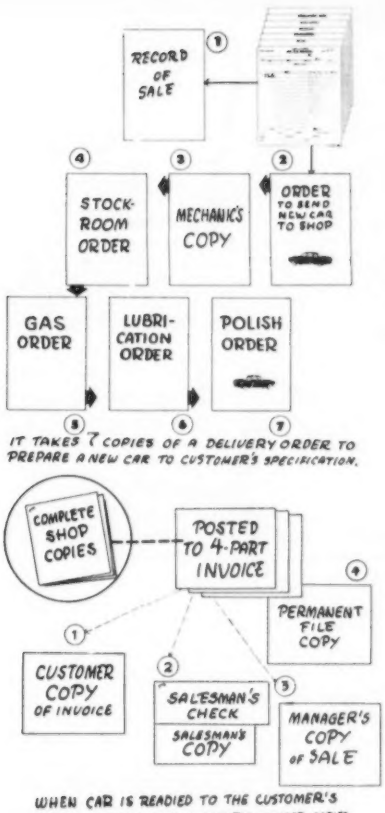
Filing Problem

Then too, there is the filing problem. With space at a premium, most offices cannot afford to give unnecessary space to such an unproductive item as bulky files filled with handsome, thick papers. To appreciate how this bulk problem can multiply itself into a kind of office space-hog, one has only to trace the required paperwork in just one operation of any familiar concern . . . a motor sales company, for instance.

When a sales company receives a new car from the factory, they must prepare a car invoice . . . usually a 4-part set of forms. All the necessary information pertinent to the receipt and inventory of the car is entered in the spaces provided *(Figure 10)* on the set and then it is filed numerically in a car-inventory file. A new car delivery order is written up and given to the Sales Manager advising him that the car described on the form is in stock. *(Figure 11)*

Upon sale of the car, the salesman fill in all the extra equipment, accessories, and services the customer requests, and removes one part of the order form as a record of sale. Six more duplicate copies of this same set are sent with the car through conditioning as follows: an order or authorization to the shop to permit the work requested by the customer; an internal material requisition to the stock room to order the accessories and other materials; a copy to the mechanic to tell him what special work is to be done; another copy orders the gasoline to be put in the tank; the wash rack and lubrication men must get a copy; and finally, the man who applies the special polishes must get his instructions. *(Figure 12)*

When the work is finished and the new car is ready for delivery, all copies of the delivery order are sent to the accounting department as proof that



Figs. 12 & 13

the services were made. Each copy is costed, and the figures transferred to the car invoice.

Part one of this invoice is then given to the customer, part two is the salesman's commission copy and is attached with similar copies of other sales to his check on pay day. The third part then goes to the Sales Manager advising him of complete information on the transaction, and the last copy is kept as a permanent car record and is filed away by the customer's name. *(Figure 13)*

Here you have seen the functions of eleven pieces of paper that had to be held in active files during the processing of a single new car for delivery to the customer. These account for an infinitesimal part of the forms any motor sales company must use in order to operate. There are many others . . . repair order forms, reconditioning orders, internal parts requisitions and purchase orders, complex payroll and tax accounting systems . . . not to mention that little sack full of warranties, service forms, and instruction manuals that is handed to the customer when he receives his invoice!

The manufacturers of paper appreciate these filing problems that face the users of printed business forms, and through their own continued research and experiment have done much to overcome them. Improvements in sizing, fillers, and methods of conversion are being made, and shall continue to be made as time goes on.

You may have observed, in the discussion of the car sales-and-inventory system, the number of copies required for distribution to the various departments concerned with the cost and production of work to be done. Multiple copies of records such as these are needed in varying quantities by every business. A number of methods have been developed for producing additional copies of originals without the risk of transcribing errors or lost time.

Carbon Manifolding

First among these methods is carbon manifolding, wherein the required predetermined number of copies are prepared at the initial writing. The entire set of forms is preprinted and either collated with one-time carbons, or have multiple-use carbons inserted at the machine through the use of a carbon interleaving device. *(Figure 14)* Both of these systems are most widely used because of their simplicity, speed and economy. Each has proved most satisfactory in doing the job required.

However, there are cases where copy requirements are far beyond the limits of carbon manifolding. In these instances there is a choice of several other duplicating methods: Offset (known by the trade name Systemat), Hectograph, Whiteprint Duplicating, or Facsimile Posting. Sometimes it is more efficient to combine the advantages of one of these with carbon manifolding methods, thus making possible carbon copies for immediate distribution.

A typical installation of one of these combination systems can best be illustrated by reviewing an order-shipping-invoicing problem of a wholesale distributor of heavy hardware and industrial supplies. This company sells some 35,000 varied items from stock, and orders must be processed within 24 to 48 hours after their receipt. Some customers demand invoices before or upon receipt of shipment and desire varying numbers of invoice copies for their own auditing purposes. The distributor has no way of knowing just how many copies any one customer will request until the order is placed. He, himself, uses eleven copies of the same form just to process an order through the warehouse. There is an acknowledgement to be sent to the customer, and a copy

Fig. 14

for the salesman, a packing slip to accompany the shipment, two labels for the package, a delivery receipt and bills of lading for the transportation service, and another copy for the warehouse accounting purposes. *(Figure 15)*

A forms-system man finally boiled this down to a simple four-part form consisting of a Whiteprint Duplicating Master (backed up by a double-faced carbon for better reproduction on the duplicator) and three additional carbon-interleaved forms. Now the salesman fills out the set, gives one copy to the customer as an acknowledgement, and sends the other three parts to the warehouse where the order is filled and shipping weights, prices, etc. are entered. The Whiteprint Master is sent to the office; the two remaining parts containing the labels, packing list and shipping papers, go with the shipment. There is no delaying office routine to interfere with

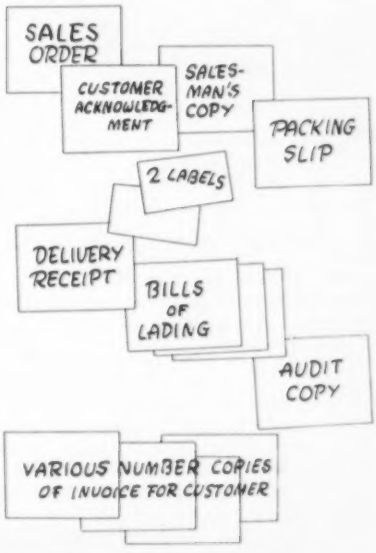


Fig. 15

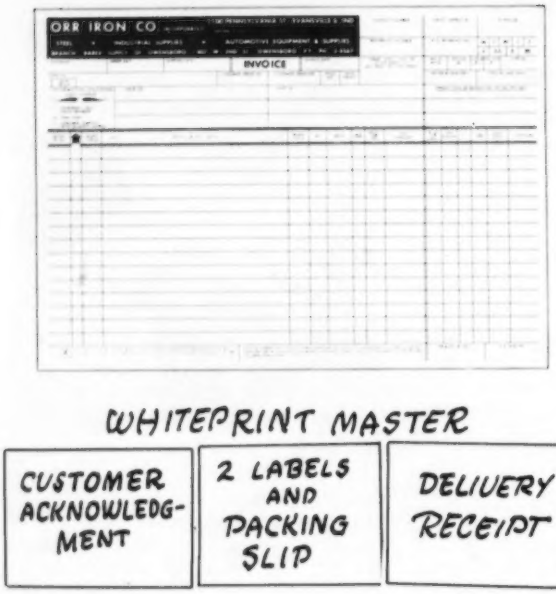


Fig. 16

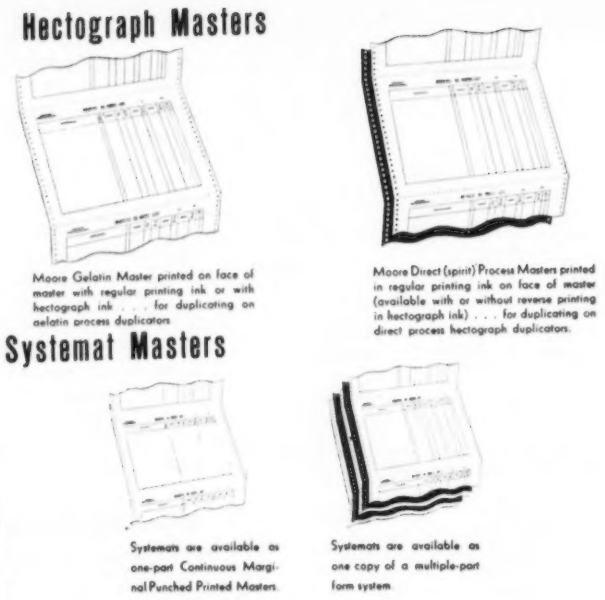

Hectograph Masters
Moore Gelatin Master printed on face of master with regular printing ink or with hectograph ink . . . for duplicating on gelatin process duplicators
Moore Direct (spirit) Process Masters printed in regular printing ink on face of master (available with or without reverse printing in hectograph ink) . . . for duplicating on direct process hectograph duplicators.
Systemat Masters
Systemats are available as one-part Continuous Marginal Punched Printed Masters.
Systemats are available as one copy of a multiple-part form system

Fig. 17

the processing of the order. *(Figure 16)*

The Whiteprint Master, with all the original and correct information, is used on a Bruning duplicating machine to reproduce as many copies as the customer and warehouse office will need. At no time is there a necessity for rewriting any of the original instructions, thereby eliminating chance transcribing errors.

Besides the obvious advantages of simplifying the forms installation, duplicating methods other than carbon manifolding are increasingly being brought to the attention of forms users. The image quality is sometimes superior to multiple carbon impressions, and it permits the use of stock heavier than that which is within the carbon manifolding limitations.

Each of these master papers is different in substance because of the different methods of reproduction used, but in general, Systemat or Offset and Hectograph Master Papers must have smooth, ink-receptive writing surfaces for sharp, unbroken image lines. Each must have dimensional stability for proper operation of the duplicator, be firm enough to stay flat, yet flexible enough to roll around the writing platen, be tough enough to withstand many revolutions on the duplicator, and much handling, filing, and reuse, but thin enough for manifolding. The surface must have erasure qualities, be able to resist fingerprints, and admit changes or additions of data between runs. *(Figure 17)*

On the other hand, the successful use of the Whiteprint Master is dependent entirely upon the degree of its transparency. Parchment papers are commonly used for this purpose, and this type of paper is very difficult to run on continuous printing presses. *(Figure 18)* There is still considerable room for experiment by converters in the transparent paper line to develop a good parchment that can be used successfully by the forms industry. The Whiteprint method of duplicating copies of original writings is becoming increasingly popular among large-volume forms users because of its simplicity, speed and legibility.

Transfer Posting

Facsimile or transfer posting is another specialized duplicating process,

Fig. 18

used to post single items from a tabulating run to a ledger card. A master paper, usually a 16-pound transfer posting paper, has been developed and has proved satisfactory for this use. The ledger card to which the posting is transferred must have a smooth, ink-receptive surface to receive a favorable impression from the image deposit dye. Normal ledger stock of high quality is not necessarily an assurance of its suitability for facsimile posting. However, stocks which have given the best results to date have had a high rag content. 110-pound transfer posting index is one stock that has given excellent results. *(Figure 19)*

All of these duplicating methods are relatively new in the business forms field and there still are many problems to be ironed out . . . particularly in the paper stock line. As time goes on we can assume there will be new and improved materials appearing on the markets, and even different and simpler methods of making duplicate copies. Many an idea that has been developed with one interest in mind has been seized upon by others who realize its adaptability to an entirely foreign and unthought-of interest.

The business forms industry is continually expanding its base stock line to meet the demands of forms users. It, too, is quick to realize potential values of ideas developed far afield from actual forms manufacturing if they have any possible adaptability to forms-system purposes.

Such a recent development is the new solvent-proof wet strength paper

FACSIMILE POSTING FORMS
TWO VARIATIONS IN POSTING MASTERS
Moore Marginal Punched Continuous Facsimile Posting Masters and Carbons.
Moore Marginal Punched Continuous Facsimile Posting Masters for use with a ribbon feeding device.
TWO FINE FACSIMILE POSTING LEDGER CARD STYLES
CUSTOM PRINTED
Continuous Ledger Cards
CUSTOM PRINTED
Unit Ledger Cards

Fig. 19

Fig. 20

which was originally manufactured by the paper converters for use in paper bags and other water-resistant wrappings. The forms manufacturers discovered that the surface of this paper could be made receptive to the printing of indelible inks which would not fade or wash off, and that the paper would retain its maximum strength when subjected to immersion in water, cleaning solutions and most other chemicals.

Their systems-men realized this kind of paper would be an ideal addition to the dry cleaning and laundry line. They designed a three-part dry cleaning form that could, with only one writing, provide a customer's copy, an office copy, a garment invoice, and any number of garment marking tags. These tags are printed on the new wet strength paper. All forms and tags are prenumbered to eliminate any chance of marking errors. *(Figure 20)*

In the beginning, wet strength paper was available only in a natural color, buit it was soon discovered that the dry claning industry has a color system set up whereby the tags attached to garments indicate day, route or store groupings. The paper manufacturers solved this little hitch by adding the various dyes to the wet strength paper stock. Now this paper has become a popular time and labor-saving, error-eliminating item in the dry cleaner line.

Literally volumes must be written before one completely covers the paper, printing, and applications field of business forms manufacturing. This limited discussion can merely skim the surfaces of just a few of the higher spots of the vocation, but it may serve as a slight indication of the vastness of the industry as it is today, and of the unlimited possibilities, yet untouched, which lie ahead for paper and business forms manufacturers.

There does remain one important fact that we should not overlook. Although the world has busied itself in the pursuit of trade and commercial enterprises for over nineteen hundred years, the greatest development, if not the only development, of business forms and systems has come about during the very lifetime of each of us. We have seen the birth and growth of a giant industry that promises a brilliant future.

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produce striking, attractive, original-like grains, patterns and textures from 10" to 90" wide...

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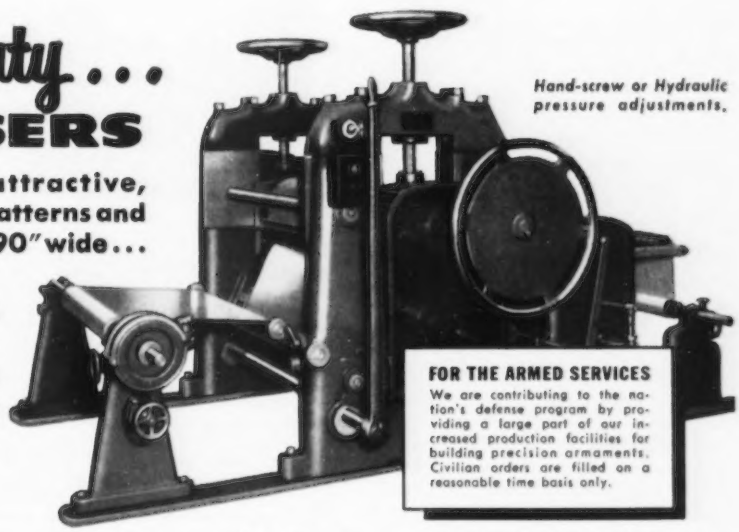
- **ON PAPER BOARDS**
- **ON FABRICS & PLASTICS**
- **ON *Imitation* LEATHERS**



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Highlights of the Envelope Industry

Eliot L. Wight

United States Envelope Co.

If someone offered you a business making a product used by every man, woman and child in the United States —a product without which no business organization, no professional, social, political, or educational group can possibly operate, would you be interested? If, moreover, that product was one which would ordinarily be used just once and then thrown away, would you still be interested?

Such is the nature of the envelope business, and from that standpoint certainly an attractive type of enterprise. That is one reason, no doubt, why there are so many people in the envelope business. And that is the other side of the story—the reason why it is pricewise a highly competitive type of business.

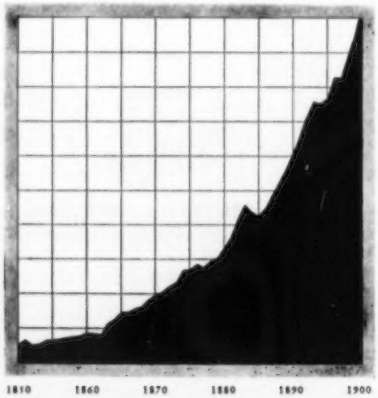
About 175 companies share the business in this country. In 1951, the last year for which the U. S. Government has given us figures, these 175 companies' combined sales were approximately 182 million dollars. Eighty of these companies belong to the Envelope Manufacturers Association. The sales of these eighty companies in 1951 were 85½ million dollars, and they sold in that year—21¾ billions of envelopes, which means an average value per one thousand envelopes of $3.928. Using this same per one thousand units value figure, and dividing it into the 182 million dollars which the Government reported as the total sales for the entire industry, we arrive at a figure of 46 billion envelopes sold by the industry in the year 1951, which is probably an underestimate.

Eliot L. Wight is advertising and sales promotion manager, United States Envelope Co., Springfield, Mass. He was born in Plattville, Wis., but lived in the East since 1900. He received his B.A. from Yale University and was 2nd Lt. Field Artillery World War I. He started business career with J. Walter Thompson Advertising Agency, New York City; subsequently was advertising manager for Hoggson Bros. bank building specialists, New York City; then registrar Bay Path Institute business college, Springfield, Mass. Since 1929, he has been with United States Envelope Co. He is past president of the Direct Mail Advertising Assn.; one time vice-president, Springfield Advertising Club; part time lecturer at Northeastern University; Trustee American International College, Springfield.

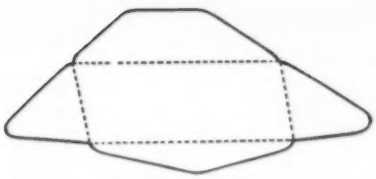
The effect of competition for this business is readily apparent when one examines the trend of the ratio of net profit to sales in the envelope industry over the last few years. The trend is definitely downward, even before taxes. So, do not make up your minds too quickly that you are going into the envelope business. Nevertheless, it is an interesting career, with a lot of fine companies providing very satisfactory earnings for a good many thousand people. The minimum wage is high, as compared to many other industries employing a high percentage of women, and the customers, whether merchants, printers, or consumers, are high grade and pleasant to deal with.

Merchandising

If you do get serious about becoming an envelope manufacturer you will have to decide about your manufacturing and merchandising policy. There are several different set-ups represented in the industry today. The most numerous is that known as "consumer plant," or direct selling group.



Gross Revenue, U.S. Post Office Department, 1850–1900

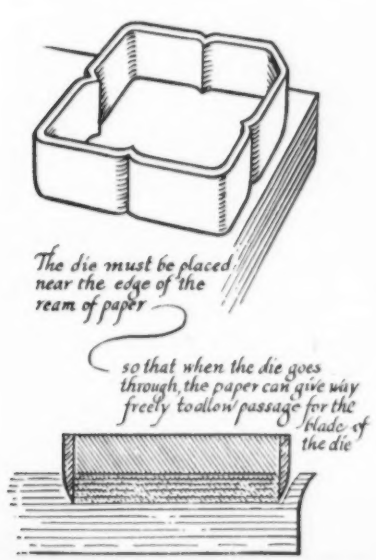


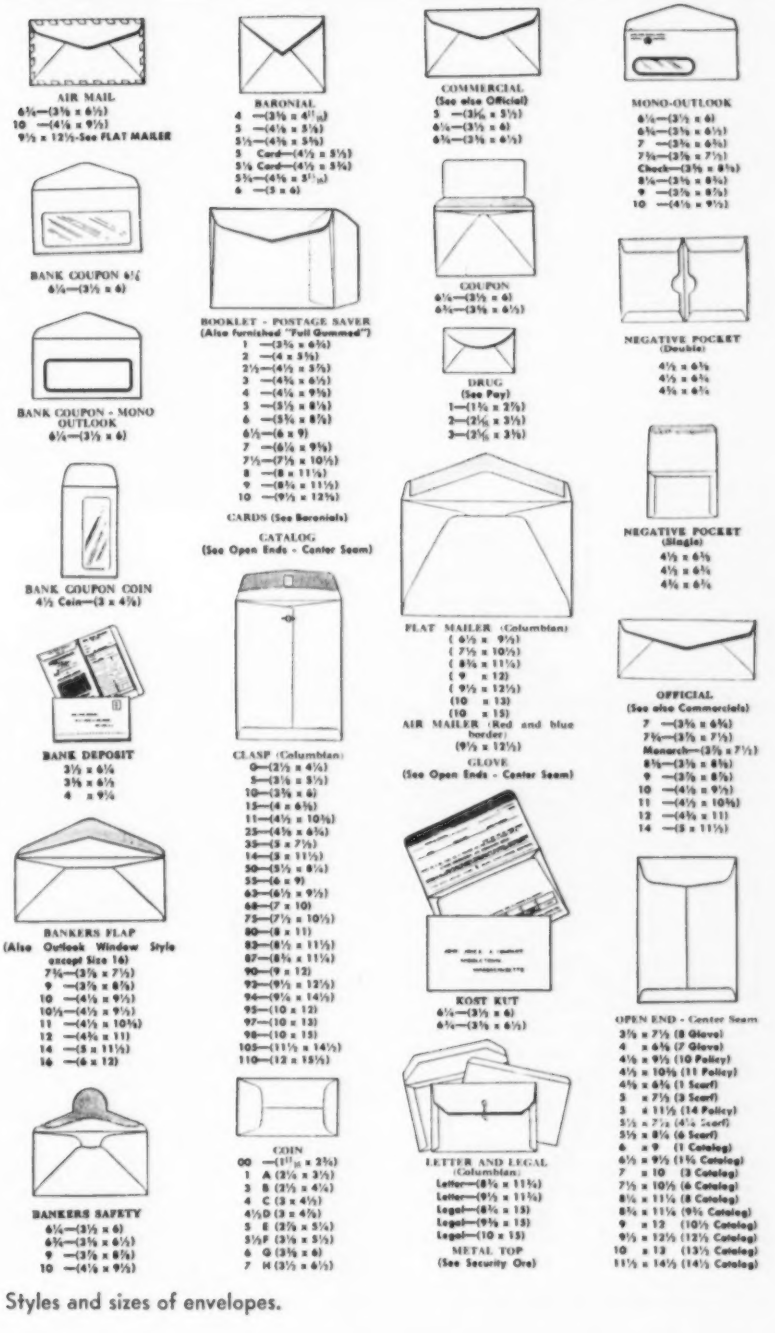
A typical shaped blank.

At least sixty percent of the units in the industry are of this type where the product of the factory is sold by factory salesmen, direct to the user of the envelope. Such firms ordinarily operate sectionally, although there are one or two who have established branches in various parts of the country, thus approaching the point of national distribution.

The next largest category would be that of the socalled "jobber plant." Its main outlet is the paper wholesaler, handling both fine and coarse papers, who resells the product. Our own company happens to belong to this group. The fine paper merchant ordinarily restricts his sales to printers, and firms having private printing departments. Some do call on large industry regardless of whether they do their own printing or not. Coarse paper merchants sell envelopes to industry, using the printing service of the envelope manufacturer to take care of the customer's printing requirements.

Envelopes are also sold by jobber plants to many other types of wholesalers, particularly banded or packaged resale stationery units. Such outlets include the wholesale druggists, confectionery jobbers, notion and novelty, tobacco, and miscellaneous wholesalers. Another large outlet for the product of the envelope manufacturer is the chain store operator—variety syndicates, drug chains, and supermarkets, being the major channels of distribution.


The die must be placed near the edge of the ream of paper
so that when the die goes through, the paper can give way freely to allow passage for the blade of the die



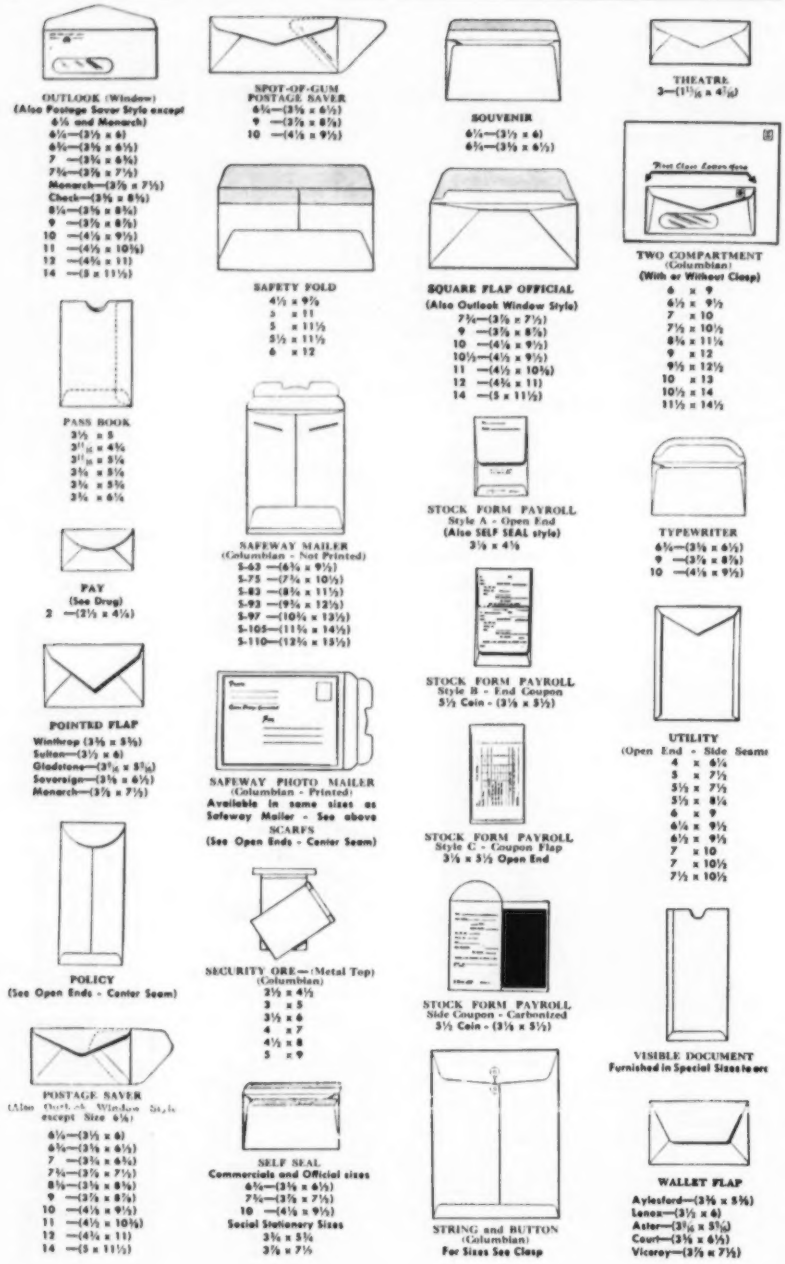
Styles and sizes of envelopes.

A small group of envelope manufacturers sell the printer directly, making him an agent.

Another category is the jobber owned plant. There are at least four large paper distributing organizations, each with many branches, which operate one or more envelope plants for the making of some of the envelope lines which the member houses wholesale.

There are also a number of specialists in this industry who act as brokers in one sense since they do not manufacture nor warehouse the bulk of the envelopes they sell, but do perform a printing service on at least a part of the orders they handle.

There is one other category, which perhaps should be mentioned. This is



Styles and sizes of envelopes.

represented by one company whose entire product is sold to the United States Government. This concern manufactures all of the Government stamped envelopes sold in the postoffices of the country. The government stamped envelope business has been given to them every four years on a contract. This concern has a tremendous investment in special machinery, which is not duplicated by any other manufacturer in the country. So there is virtually no competition for this special volume of business.

The distinctions in merchandising policies which have been outlined for the envelope industry should not be regarded as hard and fast. Changes in methods of distribution are going on in the envelope industry just as they are in all industries today in this country. There are individual firms in each of the categories who adhere strictly to one type of distribution policy today, as yesterday. Others pursue the more flexible course of selling jobbers, printers, stationers and consumers alike, depending upon the nature and volume of the business involved.

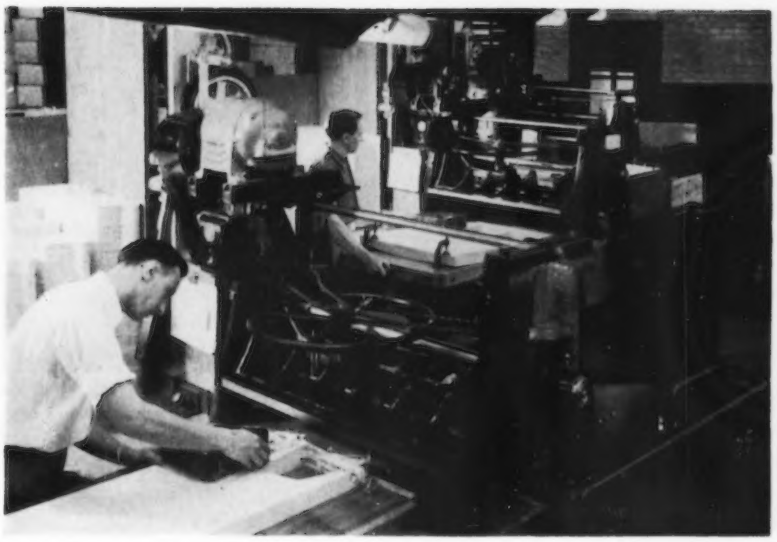
Uses and Use Requirements

I dare say, your first thought when the word envelope was mentioned was of the mailing type of envelope. This type does represent a very large proportion of the total envelopes consumed, but by no means all. Figures released by the Post Office Department, as to the number of units handled, would indicate that at least fifty percent of the forty to fifty billion envelopes used in this country annually are of the mailing type. Perhaps it is a greater percentage, for Post Office figures are only estimates. Let us say sixty percent to be conservative. That still leaves fifteen to twenty billions of envelopes of other types to be accounted for. These other types, broadly speaking, fall into two categories—envelopes used for packaging, and envelopes designed to facilitate some other business operations. These we might call "systems envelopes."

Regardless of the category into which envelopes fall from use standpoint they have certain properties in common. They all must fold well, both with and across the grain, they must take printing and writing in a satisfactory manner, they must be reasonably opaque for the most part, and finally they must have suitable strength as a container.

On top of these general characteristics ther are many specific requirements demanded of each of the three use types. In the case of mailing envelopes the shape of the flap is important, for mailing machines, inserting machines, sealing equipment, typewriters, multigraphs, and other office machines all make their peculiar demands on the envelope for best performance. In this connection with mail we also have to think of quick sealing. This calls for special gums which we shall discuss later. Then there is the matter of durability required by the trip down the mail chute and into the mail bag. There is a question of attractiveness to the eye which has a bearing on the percentage of returns enjoyed from direct mail advertising.

Packaging envelopes too have their own peculiar requirements. Here we may find transparency a desired characteristic, rather than opacity. Strength factors would ordinarily have to be higher still as compared to mailing envelopes. The closure problem would be quite different. Perhaps no flap at all, as in a "policy jacket." Perhaps a metal clasp, or a snay fastener, or



The operator places the die on the lift of paper.

a string and button, or a pressure seal. Perhaps a tin tie, or tuck-in flap, or a paper tongue, or milk bottle slot. Good printability is a must with many a packaging envelope.

In the third category—envelopes having to do with systematizing of business operations—we come to such highly specialized requirements that it is easier to suggest by example rather than to set up general classifications. In providing an envelope for use in paying employees by cash, strength and ease of closing would be the major use requirements, whereas if paying by check such things as shape of window, position of carbon area, shape of flap, opacity of paper would be the essential criteria.

Raw Materials

Two major raw materials required for the manufacture of envelopes are, of course, paper and gum. Since paper appears at the end of the paper making machine in roll form, the most economical converting process would be one which took the paper directly from the roll, printed it, applied the gum to it, and formed it directly into an envelope, in one continuous operation. Some manufacturers do use this method exclusively. Others use it for the making of a portion of their product. Our company makes some of its product by this method but a larger proportion by other methods. Until recently there has been one disadvantage inherent in this method. The envelope produced was of the side seam variety, a type not as universally acceptable to the public as the diagonal, or center seam style. It is now possible to make the preferred diagonal seam style in the common correspondence sizes by this web method. It happens that our company has pioneered a development in this direction. A few other companies are bringing equipment into production to make a somewhat similar style from the web.

As of today, however, most diagonal seam open side envelopes and center seam style open end envelopes are made on other types of equipment from blanks of paper which have been cut to the desired shape prior to being placed in the converting machine.

This machine is gumming the flaps which are to be joined.

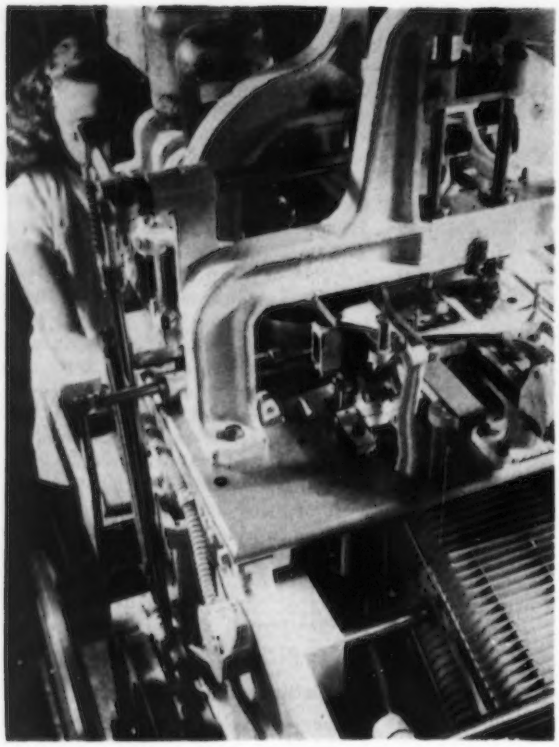
Die Cutting

Everyone is familiar with the shape of the blade of an ordinary jackknife. A cutting die is an enlarged version of the jackknife. It is forged in the shape of the outline of the blank desired and then welded into a closed knife that has no breaks. Such a die is usually 3½" high when new. The cutting edge is as sharp as a knife. The opposite edge is about ⅜" thick.

In cutting out envelope blanks a pile of paper, about 2½" high, is placed on the cutting board. Two adjacent edges are jogged so that the entire pile, or "lift," as it is called, presents two vertical edges that are perpendicularly square. The die is then placed on the lift close enough to the edge so that it will "break out" at one or more places, and still not slide off. This "break out" is necessary to allow some "give" to compensate for the thickness of the metal in the die, otherwise the paper itself would tear and prevent the next cut from being taken in its proper location. The amount of pressure required to force the die through the lift of paper is several hundred tons, and this force is provided by fly wheel, or hydraulic, cutting presses.

Blade Cutting

Since a cutting die is a fairly expensive tool some envelope blanks are cut by temporarily set up cutting blades. While this method avoids the expenditure for the cutting die it is more expensive than die cutting as far as actual cutting labor is concerned. For example, the ordinary cutter can produce approximately seventy-five thous-



The beginning of the fold which is accomplished by the plunger method.

and 6¼ blanks per hour, using a closed die, whereas he will be able to produce not more than fifteen thousand using cutting blades.

Machine Folding from the Blank

There are two general types of converting equipment for making envelopes from the cut blank—the plunger type and the rotary type.

In plunger folding, blanks are first piled on what is called the elevator. A reciprocating rod to which are attached members, called pickers, holding pieces of rubber which are moistened by the application of gum, applies the gum to the back seals, and the seal flap portions of the blank. The adhesiveness of the gum lifts the blank from the pile on the elevator, whence it is carried backwards in the machine to the actual folding position.

The blank is then mechanically detached from the picker and forced by a plunger into a folding box, where the side and bottom flaps are successively folded, and the seal flap is creased. At the moment that the folding is completed the envelope drops out of the folding box into the drying chain which is an endless belt holding the envelope until the gum on the seal flap is dry.

Rotary machines form the envelope by leading the blank along a certain pathway by means of belts. As the envelope moves along, plowshares, wires, rods, or rollers guide the flaps so that they are folded over forming the envelope.

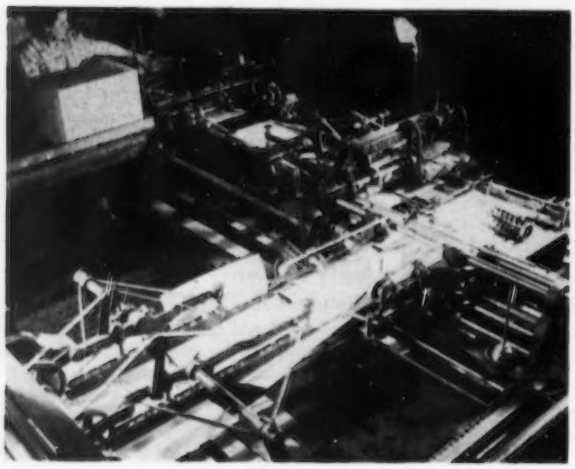
There are many different types of rotary machines, some of which are used primarily for open side envelopes, other primarily for open end envelopes. These machines vary in their mechanical detail, some stopping the blank momentarily in its travel and using moving plates while the envelope is stopped to fold the flaps over. Others reverse or change the direction of the moving envelope.

Envelope Papers

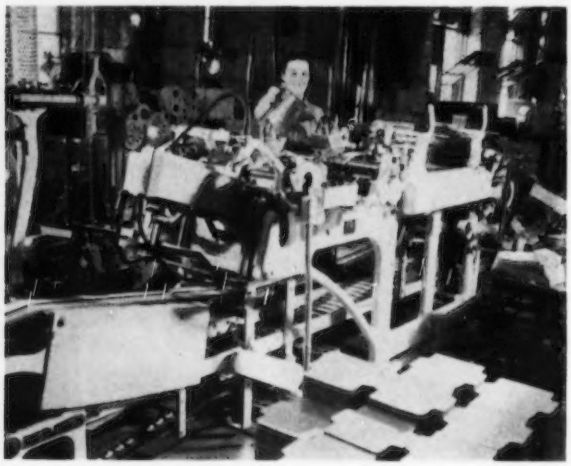
Nearly every paper in common use is utilized at one time or another for the manufacture of envelopes. However, there are certain grades which are recognized as "envelope papers." Best known among these are while wove and vellum, manila, brown kraft, gray kraft, bleached kraft, and bond.

Since envelopes are made of paper, they are subject to the same tendencies to buckle and curl, which are characteristic of paper itself. In addition, envelopes have a few warping problems of their own, due to the fact that the paper is folded both with and across the grain, and that adhesives must be added in manufacture.

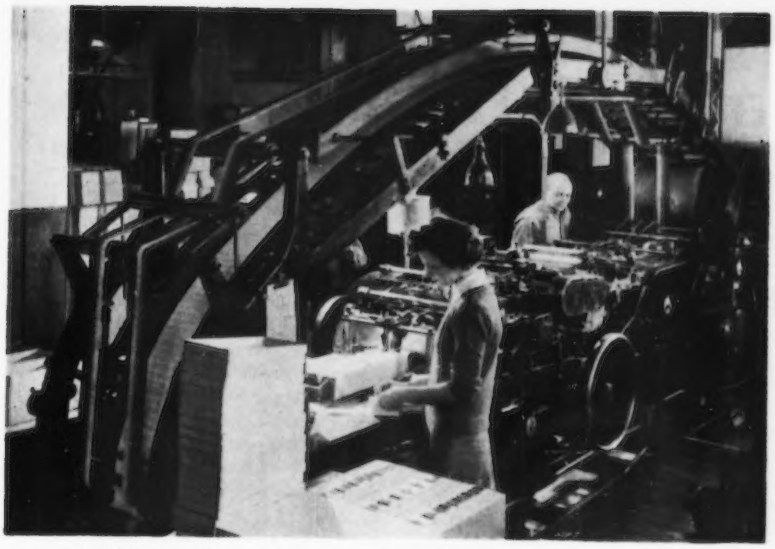
The moisture which is present to some degree in all papers is held in the fibres of the pulp from which paper is made. These fibres will absorb moisture and swell when the surrounding atmosphere has more moisture in it than is present in the fibres of the paper, and they will give off moisture and contract when the reverse is true.



Making the fold on an end opening envelope.



Applying gum to a folding machine.



A complex high speed machine with overhead drying section.

This means that a sheet of paper will swell and stretch when permitted to absorb moisture, and will contract or shrink when the moisture in it is given up. This tendency is greater in the cross grain direction than in the machine, or with-the-grain, direction.

Paper, and hence the envelope, is constantly in the process of either absorbing or giving off moisture, in an effort to bring itself into equilibrium with surrounding atmosphere.

Now to these factors, which are inherent in paper itself, we must add those arising from the converting of paper into envelopes.

Folding Complicates the Problem

Since every envelope is a folded piece of paper with some flaps folded in one direction and some in another, and the whole glued together, it will be seen that the effects of moisture changes which we have just described are greatly increased. Furthermore, open side envelopes are usually cut at various angles to the machine direction. This means, for example, that in the back seams of a number ten size envelope, one seam may be parallel to the machine direction of the sheet, and the other may lie in a cross machine direction. This magnifies any warping or curling due to humidity changes for reasons explained above.

Gums Add Another Factor

A further complication arises from the application of adhesives in making back and bottom seams, and the seal flap of an envelope. Obviously, there is moisture present in the liquid gum. This enters the paper and is then dried out.

The seal flap adhesive must evidently be made so as to absorb moisture quickly when it comes to sealing the envelope. Excessive humidity in the air prior to sealing tends to prematurely moisten this seal flap, thus adding the possible complication of tacking of the flap to that of the swelling described above, which follows the addition of moisture to paper.

As one studies all these tendencies, one begins to wonder how envelopes can ever be kept flat and free from warp and curl. Obviously, anyone who guarantees that they will always be perfect in these respects, under all conditions, is claiming the impossible, but through control of conditions during manufacture and reasonable control of storage conditions most of the difficulty is overcome from a practical standpoint.

It is evident that the elimination of warping and curling, and of premature "tacking" of the seal flap of an envelope, are matters of moisture control from start to finish.

The user of envelopes is entitled to a product which reflects the standing of its user impressively, which speeds the delivery of the sender's mail invariably, and safeguards its contents unfailingly. It is, therefore, the objective of the envelope manufacturer to deliver these benefits to the buyer through the characteristics built into his product. He seeks to have them make favorable impressions through functional modern design, high bulk, and the quality feel of their finish. He aims to have them deliver the most protection because of rigidly tested papers, and the application of proper gums for quick, secure, sealing. He plans to have them readily printable through wide seal flaps, high back flaps, which reduce problems of make-ready, through surface characteristics which have an affinity for ink, and which permit the ink to dry quickly as well as through the envelope's perfect cut and folding so that it will lie flat for press feeding. He strives to have them easy to handle and to load, and to that end gives them smooth folds by means of minutely adjusted equipment; also he rounds the shoulders of sealing flaps so the envelopes will guide and glide swiftly through mailing and sealing machines.

That envelope manufacturer is fortunate who has, in addition to converting equipment, his own machine design and construction department, his own laboratory for testing papers and for manufacturing and testing gums, as well as his technical department for setting up standards for quality control and procedures for adequate product inspection. For envelopes are used everywhere under every extreme of temperature and humidity, from fifty degrees below zero in the arctic to ninety-nine percent relative humidity in the steaming jungles, and the problems involved in making a product which will perform satisfactorily under such extreme variations call for technical "know-how" of a high order.

Inspection of the finishing envelopes and placing in boxes.

Tags, Labels and Tickets

R. S. MacKenzie

Dennison Manufacturing Co.

It is indeed a privilege and a pleasure to have this opportunity to discuss with you certain of the many converted paper products with which my company concerns itself. Dennison doesn't manufacture a pound of paper but there are few grades which we have not converted in one way or another over a period of 108 years.

We will deal with two classes of those converted paper products — namely, tags and labels.

I am sure that none of you will quarrel with the statement that few things are in more common usage than tags and labels. And I am sure that if you were asked, you would define a tag as a piece of paper or cloth tied to an object by a string or wire; and a label as a piece of paper stuck to an object by an adhesive. I mention this distinction between the tag and the label only because when we entered the tag business some 90 years ago what we now call "shipping tags" were known as "direction labels."

While you all recognize how much the tens of thousands of tags and labels differ in kind and in use, you all recognize that they all do one thing: They tell something about the item to which they are attached. One tag tells the price of a dime-sized wrist watch; another, with multiple sheets attached, pursues a shoe from raw hide to shipping room. A label marks Aunt Jenny's gooseberry jam or a bottle of Moon Swoon perfume.

When we consider the subject of tag and label manufacture, we recognize that their common purpose of telling calls for certain like qualities—as a suitable writing surface, a durability sufficient for the task at hand, and a satisfactory fastener or binder. Obviously, the difference in the structure of tags and labels calls for different methods of manufacture.

R. S. MacKenzie is a graduate of the Lowell Textile Institute, Lowell, Mass. After a brief period of association with the American Woolen Co., he joined the Dennison Manufacturing Co. in 1927. His activities included raw material testing, paper conversion production, accounting, and other phases of operation. Mr. MacKenzie is presently serving as assistant merchandise manager for Dennison.

We shall turn our attention first to tag manufacture. As we do so, we shall differentiate between the two principal classes of tags—known in the trade as patched tags and marking tags. Patched tags, often called shipping tags, are distinguished by the familiar paper washer around the hole, through which the string or wire passes. Marking tags do not have the patch, but in some cases the hole for the string is reinforced by a metal eyelet. Generally speaking, patched tags are designed for rougher usage than marking tags and are made of tougher stocks.

Raw Material

Patched tags are manufactured from a heavy, tough paper stock made especially for the tag industry. Tagstocks are differentiated on the basis of kind, weight, thickness, surface finish, and color of material. The principal kinds of tagstocks are:

Rope—made of hemp from used rope.

Jute—made of fibers from discarded burlap bags.

Chemical Wood—made of sulphate pulp or sulphite pulp.

Ground Wood — made of ground wood pulp.

Cloth—made of cotton fibers impregnated with a clay filler.

The basis weight of the tagstock is determined by the ream of 500 sheets 22½" x 28½". Thickness of tagstock is measured in points of 1/1000th of an inch each. The most common weights are from 100 lbs. to 200 lbs., with 100-lb. stock calipering 10 points and 200-lb. calipering 20 points.

Plain tagstocks have the natural color of their pulp, which has been only partially bleached; and are called "manila" tagstocks. Colored tagstocks are made either by putting color in the pulp or by coating. As coated stock has a smoother, more even surface than dyed-in-the-pulp stock, we at Dennison coat our colored stocks.

Tagstocks are graded by quality, weight, and thickness. Grades have been standardized by the Tag Manufacturers Institute for the Tag Industry, and industry symbols have been adopted for each.

Testing

The tagstock arrives at the converter's manufacturing establishment in large rolls weighing approximately 1200 to 1500 lbs. A sampling of each lot is made and submitted to our test-

ing laboratory. The laboratory, uses a variety of TAPPI tests. In addition to testing for weight and thickness, the laboratory tests for tearing strength, also for surface quality, color matched to standard, formation, and cleanliness.

The results of the laboratory tests will indicate whether or not the particular shipment being judged will meet the requirements not only of our own processes but also of the particular consumer use for which the particular grade in question is being analyzed. The shipping tag which we are to produce will probably be made in one of eight standard sizes, ranging from 2¾″ x 1⅜″ to 6¼″ x 3⅛″. These sizes are well recognized in the trade, in most government specifications, and have been set up for economy in manufacture and to cover a wide range of uses. The length of a standard size tag is twice its width, and each succeeding size increases by ½″ in length and ¼″ in width. The largest so-called stock tag is a size 8, which is 6¼″ x 3⅛″. Obviously, there are tag requirements exceeding this size, which are called "large tags," such as express waybills; tags for record and routing purposes; for production time and piece-work records; tags requiring several coupons or slip-sheets. However, whether our tag is to be of a standard size or a large tag, the same principle of operation is followed in its manufacture.

Tag Manufacture

As the initial step in manufacture, the jumbo rolls of tagstock as received from the mills are slit into sizes corresponding to the length of the tag desired. Our No. 1 tag would be then manufactured from a roll of stock 2¾″ wide.

The equipment for making patched tags operates from one long power-driven shaft, so that a continuous series of operations may be synchronized to make the complete tag. While different types of machines are used to make simple and complex tags, the sequence of operations differs only slightly on the various machines.

The roll of tag stock is released to the machine by an unwinder, which allows some slack. The passage of the strip of tagstock through the machine is controlled by a feed roll.

The first step in making the individual tag is a twofold synchronized operation. Two strips of gummed and moistened paper stock to form the patch or reinforcement are fed into the machine, one on each side of the strip of moving tagstock; and are sheared off at proper length, punched through, and sealed firmly by the punching apparatus used to form the hole in the tag.

I am of the opinion that manufacturers may not all follow this particular patch application procedure, as facilities have been operated whereon the patch is actually glued with a bulk adhesive to the tag rather than originating as a gummed patch stock. As the stock passes beyond the punch head, a V-shaped knife cuts a notch to form successively the cut corners of the tag. You may be interested to know that wooden mummy tags, which are preserved in the Metropolitan Museum in New York, have the familiar cut corners.

As the next step in our particular manufacture, the patch or reinforcement is identified by being imprinted with our manufacturing name, together with the symbol for the particular tag stock employed.

If a plain tag—that is, not printed—is being made, a knife now cuts the individual tag from the moving strip. If, however, a printed tag is being made, the strip of tag stock is passed through one or more flat-bed presses, depending upon the number of colors used. After printing, the individual tag is cut from the moving strip and passes on to a belt for automatic counting, inspection, and boxing.

Patched tags may be reinforced at the hole with metal eyelets. They may be; couponed, die cut into irregular shapes, numbered, or they may be made in "gangs" of from 2 to 1000. Such special features are added by the incorporation of special equipment within the machine; or, in the case of "gangs," by adjusting the cut-off knife.

Standard sizes of patched tags are strung or wired automatically on special machines. Other sizes of tags or those requiring special fasteners are strung or wired occasionally on semi-automatic, specially developed machines, or in some instances as a hand operation.

Special treatment of the finished tags may include lacquering or paraffining, which type of treatment is a surface application conducted as a separate operation. In this category you would find a battery tag, a meat tag, or various other specialties which must resist acids, greases, or other substances. We have dwelt upon the quality and method of tag manufacture; and in passing perhaps should mention the human element which is still a very important part of the procedure. The number of people operating a given tag machine depends largely upon the size and complexity of the item. Such operations as installing the raw material on the machine, setting the type faces, making adjustments may call for a male operator; whereas inspection, boxing, etc. is usually considered work for female help.

Gummed labels and embossed seals designed and produced by Dennison Manufacturing Co. are effective packaging accessories. They identify the merchandise and present selling features.

Marking Tags

Marking tags, as the name infers, are used primarily for price-marking, for identifying, or for giving information about merchandise. This affinity, so to speak, of marking tags for merchandise opens up advertising opportunities, which involve a high order of printing skill. As marking tags are generally not subject to the hard usage, they do not have the characteristic patch.

Marking tags, generally, require a stock with a smooth finish adaptable to writing and printing. Strength of stock must meet specific needs. The same chemical wood pulp stocks used for patched tags, when coated, are suitable for most types of marking tags. When inexpensive tags are required, an all kraft sheet is generally used.

There are two recognized methods of making marking tags, one of which makes the tag complete in a series of operations on a single machine; the other method employs two or more machines.

Plain marking tags, and in some cases tags printed on two sides, are produced in a single complete operation. The strip of tag stock again is moved through the machine by roll feed. If plain tags are being manufactured, the string hole is first punched out; the tag is then died out and passed through the stringing equipment. The tags, after being counted automatically, are inspected, tied in bunches and boxed. If printed tags, involving not more than two colors to the side are being made, the strip of tagstock passes first through the printers; and then follows the same procedure as plain tags.

When superimposing one color of ink upon another will produce a poor effect; when close register (that is, colors contiguous to each other) cannot be handled in two quick successive steps; or when lacquering, paraffining or bronzing are required, then two separate manufacturing operations are used. Upon the first or "roll-up" machine, so-called, the tag stock is printed; hole punched for feeding in the succeeding operations, and rolled up; the copy may be printed in single rows or in multiple rows up to 5, depending upon the size of the tag and size of the order. The second machine prints superimposed colors, if any, punches the string hole, dies out, and delivers the counted tags for inspection and boxing.

When marking tags are lacquered or paraffined, this step is a complete process within itself, and involves extra operations between the printing and the finishing. We mentioned the lacquering or paraffining of patched tags to protect the surface. This is also true in the case of marking tags but, in addition, a lacquered surface is frequently employed to enhance the appearance of the marking tag. The lacquer may be applied full coverage or in stripes on either or both sides.

These tags are attached by strong twine or wire. The paper reinforcement around the hole gives the tags great pull out strength. Besides their use as shipping tags, these tags perform many industrial uses such as parts identification, routing, piece work, inspection, and warehousing records.

Most marking tags are equipped with string, while others have strings with barbs attached. They may have wire hooks for attaching purposes—all depending upon the ultimate use. As with patched tags, marking tags may be equipped with metal eyelets, may be numbered or couponed as part of the series of manufacturing operations; and are often punched with special slots for attaching to buttons and the like.

Labels and Seals

Departing now to the manufacture of labels and seals, no doubt a layman might consider them pretty much the same thing. To a manufacturer, however, a label is one thing and a seal something entirely different. The method of making labels differs significantly from the method of making seals.

Labels are printed from a roll or in flat sheets, and are cut out separately, the manufacturing process thus requiring two or more operations. Seals, which are characterized by an embossed edge and an embossed design, are produced by a die that prints, embosses, and cuts out the seal in a single operation. Seals thus produced we designate as "French edge" seals.

The countless uses for labels and seals are readily recognized. Obviously, the wide range of uses calls for corresponding differences in qualities of paper, printing and adhesives.

The papers from which most labels and seals are made come under the general classification of "book papers." For special uses, however, such materials as glassine, greaseproof paper, cellophane, metallic foil and cloth are employed. The "book papers" are designated by weight on the basis of 500 sheets 25″ x 38″ and generally range from 40 to 70 pounds.

Gumming

In the manufacture of a label or a seal, its specific use determines the quality of paper, design, and gumming. A large percentage of the papers used in the manufacture of labels are gummed papers, so-called, which are another paper-converting process. Gumming is not usually considered as a part of label manufacture. We are fortunate at Framingham in having our own gumming facilities, and I have, therefore, come to think of gumming as a part of label manufacture. We mention it only briefly and to point out that gum must be applied to these papers in such a way that they will not curl but will lie flat through the label manufacturing process.

The kind of adhesive used depends upon the surface to which the label will adhere, which might include a corrugated box, metal, an aluminum pot, a tin can, a plastic surface, or what have you. In recent years adhesives have been developed which depend upon heat rather than water or another solvent to activate the adhesive. These heatseal adhesives are used particularly where labels are to be attached automatically. Even more

recently pressure-sensitive adhesive has taken its place as a basic adhesive and all of these various types of adhesives challenge the label manufacturer's know-how. The large label manufacturer is usually equipped to carry out all the necessary steps in design and copy layout. He uses monotype, linotype, and photoengraving facilities. He is equipped to produce by various printing methods, which may include letterpress, offset lithography, or rotogravure. Labels as distinguished from seals may be printed in sheets, often from gang electrotypes, and are cut out in single pieces or in strips which may be rolled.

Cutting Out

In the cutting-out process there are, again, several methods, which include shear-cutting, bent-rule, and die-cut. Shear-cutting is done by a guillotine machine equipped with a knife operated to cut lifts by a downward power-driven pressure. This method gives precision cutting and trimming where straight edges and square corners are required.

Bent-rule cutting is used for labels with irregular edges, when the run is small or when the labels are too large for economical use of a die. To form the bent-rule, a steel rule, usually ⅛" thick, with a sharp edge, is bent to the shape of the label. Sheets of printed labels are then cut individually by bent-rule on hand-fed presses.

Die-cutting is done by a hollow steel die, which is forced down, generally by power. The die is made to the desired shape of the finished label. The labels which are to be die-cut are usually printed with borders larger than those of the finished label. Before the die-cutting operation, sheets of labels in lifts of 15 to 50-again, depending upon the weight and the furnish of the stock—are fastened together with the labels similarly placed on each sheet.

The usual boxing, banding, and tying procedures follow the manufacture of the labels.

French Edge Seals

The name "French edge" is said to originate with the geographical location of the first embossed seal presses, and that descriptive name—regardless of its origin—is commonly used with a number of the embossed seal manufacturers, particularly in the east. French edge embossed seals are produced on special equipment, which prints, embosses or debosses, and dies out in a continuous series of machine processes. Such seals are generally decorative, as well as being a type of label which tells something. Metallic gummed foils probably constitute the largest percentage of seals. Stock which has been previously slit into a width just a little wider than a seal is drawn from a roll onto the machine. The seal is printed, embossed, and died out in one operation. The skeleton, matrix or waste part of the paper is rerolled to keep it out of the way at the same time the finished seal is carried forward from the bed of the machine to the operator, who inspects and places seals in boxes or envelopes.

Embossing or debossing is accomplished by pressure of the die onto a synthetic board base. In embossing, the flat part of the die registers the ink, while the other part of the die permits the embossed area of a design to be raised from the surface of the seal. In debossing the debossed area of the design is raised on the die and is sunk into the surface of the seal. The debossed area can be printed but the embossed part cannot. In manufacturing seals up to four colors can be printed, with a separate die printing each color. The cutting edge is on the die, which lays the final ink color.

No mechanical means of drying inks are employed, and we depend upon oxidation. Offset—that is, the ink from the surface of one seal depositing itself upon the back of the next seal—is not a problem because of the nesting quality of the embossed seals, except when the ink coverage is particularly heavy. In such a case, special precautions are required to allow drying and to prevent this smudging or offset. The seals must frequently be racked in small lifts, or piles, or even singly for drying.

The advantages of the French edge seal method are many, including uniformity of borders, frequently lower manufacturing costs for equivalent designing effects, as compared with trying to make an embossed label, frequently less preparatory work, making for more prompt deliveries, and certainly effectiveness of design that can be produced. Again, packaging of made-to-order labels and seals is extremely important and has been developed from the standpoint of protecting the finished product, getting it to the consumer not only in first-class condition, but also with due consideration to the most convenient handling in a customer's office or factory. Special consideration is given to the use of labels, whether for hand-attaching or for automatic attaching in package development.

Marking tags and booklet tags like these are called informative tags, because they give product information to customers and salespeople at the point of sale.

Converting of Carbon Papers

F. Bruce McFarland

Port Huron Sulphite and Paper Co.

F. Bruce McFarland spent his first five working years learning the printing trade. He entered the employ of the Port Huron Sulphite & Paper Co., Port Huron, Mich. in December of 1932 in the sample and advertising department. In July of 1935 he was sent to Chicago as salesman and manager of the company's Chicago office. He served three years with the U. S. Army. He was wounded in action at Stolberg, Germany in the fall of 1944. He returned to Port Huron Sulphite & Paper after release from the Army and was appointed assistant sales manager in 1946. In 1951 he was appointed general sales manager. He has been actively engaged in the selling of the carbon paper products produced by his company as well as the sales of carbonizing tissues.

I would like you all to know that I am not a carbon paper expert. At Port Huron we make one-time carbonizing tissue, some pencil carbonizing papers, and we carbon coat the one-time grade and a very small quantity of pencil carbon. I have, however, tried to prepare a paper for you to cover this subject and wish to acknowledge assistance from George Bennethum of the Miller-Bryant-Pierce Co., Aurora, Illinois, Kenneth K. Lawson of the Standard Register Co., Dayton, Ohio, and several of my associates at Port Huron.

I would like to say to the undergraduate students of this school that there is a crying need for technically trained men in the carbon manufacturing field.

History of Carbon Paper Manufacture

Carbon paper was invented in London, England by Ralph Wedgewood. The inventor regarded it only as an amusing novelty and used it to entertain his friends. Twenty years later, however, in 1823 carbon paper was produced in Concord, Massachusetts by Cyrus T. Dakin. His work apparently had been carried on independently, because he claimed an original invention and had never heard of Wedgewood's paper. Dakin went to New York the following year, and his name appears in the New York Directory of 1826 as a "saddler." In the directory of 1832, however, his name appears as a "manifold writer." He continued to manufacture carbon paper although his principal market was among bookmakers for use in gambling records. By 1868 however, the Associated Press was using carbon paper for making pen and pencil copies of dispatches and was taking the entire output of Dakin's plant.

In the same year, 1868, Lebbeus H. Rogers, a grocery clerk in Cincinnati, celebrated a memorable day. It was his twenty-first birthday and he was made a member of the wholesale grocery firm where he was working. He celebrated the double occasion by making a balloon ascension and visiting the office of the Associated Press. There for the first time he saw carbon paper being used. He obtained several sheets of carbon, cut them to size, and adapted them for making extra copies of his correspondence. *Rogers,* was, *therefore, the first man in the world to apply carbon paper to business where it rightfully belongs.*

By 1870 he was convinced of the large field in business for carbon paper. He resigned his connection with the firm in Cincinnati and left for New York. Enroute he stopped in Washington, demonstrated a manifold book which he had conceived, and closed an order for $1,500.00 with the War Department. This was the first time carbon paper was used by the Federal government. Rogers then organized the firm of L. H. Rogers & Company and undertook the difficult task of converting business to the use of his product.

In those days carbon paper was made entirely by hand. A mixture of lamp black and lard was simply smeared on tissue paper by means of a stick which had a piece of carpet tacked to one end. In 1887 machine manufacture of carbon paper was started, and wax and oil bases substituted for the lamp black and lard mixture. An amusing story is that double face carbon was developed for use in salesbooks so that dishonest clerks could not change figures without it being detected.

Kee-Lox Mfg. Co., Mittag and Volger, and Miller-Bryant & Pierce were early manufacturers in this field, the latter starting in 1896.

Grades of Carbon Paper

There are many grades of carbon paper being manufactured today. Please bear in mind that all weights given for carbon paper are for the base tissue and not the coated paper.

Typewriter Carbon

Boxed typewriter carbon is probably the best known of the carbon paper field as it is used by everyone who has a typewriter. It is manufactured in lightweight or featherweight which is the trade name for 4 lb 20x30-480. The next weight made is 5½ lb to 5¾ lb. and this is called medium weight. Split weight is 6¼ lb.; standard weight, which is the most popular weight, is 7 to 9 lb. Heavy weight is 10 lb. to 12 lb. Billing carbon is manufactured in 12, 15 and 20 lb. weights. The determining factors in which of these weights is to be used are the size of the type on the typewriter, the touch of the operator's fingers, the platen which is installed in the typewriter and the weight of the form to be typed. Platens are made in varying degrees of hardness to assist in the procuring of good copies. Medium weight is usually used for 4 to 8 copies of a let-

ter; under 4 copies standard weight is normally used. Here again the number of copies, the platen, and the operator's touch are the controlling factors. This grade of carbon paper is manufactured in black, blue, purple, green, red and brown ink on white, blue, purple and brown colored raw stock. It is made in the following intensities; extra hard, hard, medium hard, medium, medium intense and intense.

The various colors of ink and raw stock are for appearance only. The wide range of intensities is to fit the varying requirements for up to 15 good copies. This grade of carbon usually is sold packed in 100 sheet boxes of four folders containing 25 sheets each in size 8½x11, 8½x13 and 8½x14. However the manufacturer of typewriter carbon is constantly furnishing very small quantities of all different cut sizes. Many grades of typewriter carbon are printed on the reverse side before coating for identification. Many grades now have a wax back for the elimination of curl and the improvement of appearance.

Pencil Carbon

Pencil carbon paper is made in single face and double face. This is also called semi and full coated. It is normally manufactured in basis weights of 9, 12 and 15 lb. 20x30-500. The base stock used is white, blue and red, and it is coated with black, blue, purple, red and green inks. It is made in hard, medium and intense finish, and when boxed for resale in the stationers store is usually packed 100 sheets to a box, 25 sheets to a folder. All double face pencil carbon must be interleaved. There are two kinds of pencil carbon, pigment and oil soluble. Pigment type is insoluble in alcohol or water and it lacks brilliance of color but has indefinite permanence. Oil soluble type is most soluble and is made from aniline dyes. It has brilliance of color but the copies are not permanent to light. Normally 15 lb. is used for one or two copies, 12 lb. for 3 or 4 copies, and 9 lb. for over 4 copies.

Roll Pencil Carbon

Roll pencil carbon for register rolls is usually 15 lb. and is made up in one, two, or three ply rolls. 10 lb. is used for four, five, or six copies. All roll carbon must be non-tack, which means the carbon makes a good copy but releases itself as the pencil pressure is released.

Hectograph Carbon

Hectograph carbon is the name usually gives carbon paper that is used to make masters for duplicating equipment. It is made single face in blue, purple, red, green and black shades with hard, medium, and intense finishes. It has always been messy to handle, and now some of the leading manufacturers are applying an overcoat of low melting point wax to eliminate some of this smudge. Hectograph carbon must be broken down into two classifications:

1.—Gelatin or indirect process. This type is made by coating 9 or 10 lb. sulphite carbonizing tissue with hectograph ink. In using this process a master copy is made by typing, writing or drawing in the conventional manner with a top sheet, a sheet of hectograph carbon face down on a special smooth hard surfaced paper that will not absorb the ink, but will act as a transferring agent for the ink to the gelatin surface. This master copy is then pressed into close contact with a special pad or roll with a gelatin surface made of glycerin, gelatin and water. This type of carbon paper is made with aniline dyes that are slightly soluble on this gelatin surface. Copy paper that is especially made with a smooth surface and some absorbing qualities is then used to make copies by taking small quantities of this ink from the gelatin pad or roll. This hectograph carbon will make 35 to 100 good copies.

2.—Spirit hecto or direct process carbon is usually coated on 40 lb. 25x38 carbonizing stock of a 100 per cent sulphite furnish. The coating contains a dye that dissolves in alcohol. The carbon paper is placed with its coated side against the back of the first or ribbon side of paper so that the typewriter makes a reversed or negative copy on the back of the sheet. This reversed typing is the master copy from which prints are made and this master must be a high grade of coated book stock. The master copy is fastened to a cylinder and the copy paper is moistened by passing over a wick which has one end in an alcohol bath and is then pressed against this master to make the copies. By this process 400 to 500 copies can be obtained.

Transfer Posting Carbon

Transfer posting carbon which is coated with black and red inks for one or two writes is similar to spirit process duplicating carbon and is made for exclusive use with International Business Machines.

Carbonized Book Paper

Carbonized book paper is made with 40 lb. 25x38 book stock of white, pink, blue and green shades and coated with blue and black inks. It is made in hard and intense finishes. It is manufactured in both sheets and rolls. Absolutely no penetration of the carbon ink to the reverse side of this paper is permissible because it is usually printed on the uncoated side.

Carbonized News and Carbonized Halftone News

Carbonized news and carbonized halftone news is made in basis 30 and 35 lb., 25x38. It is coated with blue and black inks of hard and intense finishes in sheets and rolls, and here again no penetration is permitted because of printing on the uncoated side.

One-Time Carbon Paper

One-time carbon paper is furnished in 5½ lb., 7¼ lb., 8 lb., 9 lb., 10 lb., 11 lb. and 12 lb., 20x30-500. The inks are black and blue and it is manufactured with hard, medium, intense and extra intense finishes. In sheet form it is sold in large size reams 26x39, 22½x34, etc. It is also furnished in all cut sizes. The jumbo rolls from the coater can be solid coated with 1/16 to 1/8 inch selvege edges or with any desired width edges or continuous stripes of any required pattern. It is supplied in jumbo and slit rolls as well as sheets.

Typewriter Ribbons

It is worthwhile to note that paper typewriter ribbons are growing very rapidly in use, especially on electric typewriters. They are used once whereas the silk ribbon is used over and over. Special rag and mixed rag and sulphite papers of 4, 7, 10 and 15 lb. basis — 20x30-500 are being used. They are being supplied in hard, medium, and intense finishes. They are coated in jumbo rolls, then rewound on the proper size cores in the proper diameter and then guillotine cut into the exact widths of 5/16″, 9/16″ and 1/2″.

Spot Carbonizing

There is one other type of carbon coating in existence and that is the spot carbonizing as done on a printing press either continuously or by blocks on paper just as the strips on back of checks or on express bills of lading.

Leading Manufacturers of Carbon Paper

The leading manufacturers of carbon paper are as follows:

Boxed Typewriter and Pencil Carbons— Columbia Ribbon & Carbon Mfg. Corp.; Kee-Lox Mfg. Co.; Miller-Bryant-Pierce Co.; Interchemical Corp., Ault & Wiborg Carbon & Ribbon Division; Burroughs Adding Machine Co.; Underwood Corp.; Royal Typewriter Co.; Carters Ink; and Remington-Rand, Inc.

Hectograph Carbon— Ditto, Inc.; Rose Carbon & Ribbon Co.; Old Town Carbon & Ribbon; and Columbia Ribbon & Carbon Mfg. Corp.

One-Time Carbon— Frye Manufacturing Co.; Columbia Ribbon & Carbon Mfg. Corp.; Queen Ribbon & Carbon Co.; American Carbon Paper Mfg. Co., Ennis, Texas; American Carbon Paper Co., Chicago, Ill.; Interchemical Corporation, Ault & Wiborg Carbon & Ribbon Division; and Port Huron Sulphite & Paper Co.

Many of the leading forms manufacturers have further integrated their operations by having their own carbon coating departments, namely: Moore Business Forms; Standard Register Co.; Uarco, Inc.; Egry Register Co.; and Rotary Printing Co.

These private carbon plants produce a very large share of the one-time carbon paper used in the forms industry. Firms like Burroughs Adding Machine Co., Underwood Corp., and Remington-Rand Inc. carbon coat book paper for resale through their service departments for use on their adding and bookkeeping machines.

Uses of Carbon Paper

Typewriter Carbon

Typewriter carbon papers are used for making copies of letters, records, billing machines, and copying of all kinds.

Pencil Carbon

Pencil carbons are used for duplicate copies written with pencil or ballpoint pen primarily in the salesbook or autographic register field.

Carbonized Book Paper, Carbonized News, and Carbonized Halftone News

Carbonized book paper and carbonized news and carbonized halftone news are used exclusively in salesbooks, dining car checks, adding machine and bookkeeping machine rolls, meters such as on oil trucks, scale tickets, hotel slips and marking carbon with pattern paper.

Hectograph Carbon

Hectograph carbon both direct and indirect process type is used on duplicating machines to produce inexpensive copies.

One-Time Carbon

One-time carbon paper which is by far the largest tonnage grade of all in this field is used in the manufacture of forms, and it is well worthwhile to consider the make-up of some of these forms.

One-time carbon is used only once and is necessarily low cost. It's use has been developed by the sales effort of forms manufacturers in convincing systems engineers that it is cheaper and faster to throw away one-time carbon than have girls waste their time interleaving forms by hand.

The first type of form is the non-padded cut forms in which any kind of carbon paper can be interleaved. Next come the padded forms which are precollated with either one-time, pencil or typewriter carbons. Then the fanfold forms which are printed in wide rolls and folded back and forth with edge perforation on the folds which are used with typewriter carbon in sheet or roll form or with one-time carbon. The next type is unpunched continuous one-time carbon interleaved forms that are fed through typewriters or billing machines with no control of alignment or register or with autographic registers. We then have marginally punched continuous forms that are not interleaved with carbon paper and these forms are used with floating typewriter or pencil carbons in sheets or rolls. A carbon shifter must be used with this type of form to interleave the carbon. Next is the marginally punched continuous form interleaved with one-time carbon. These forms are punched to fit a sprocket feed so that all copies remain in alignment for registration. Another type of continuous form is the one that is punched for sprocket feeding on tabulating machines. Another type of form that is manufactured by many companies, large and small, is the unit set or snapout form. This is a two or more part form interleaved with one-time carbon and fastened at top, bottom or side by glue, staples, or stitching. The form is perforated so that the one-time carbon paper can be separated from the copies by a snapping of the wrist. The carbon paper is short about ½" so that the stub can be held in one hand and form in the other to pull apart. A side fastened snapout set can also be procured in a continuous form .

Hectograph carbon, either gelatin or spirit, can be furnished in many of the type forms discussed. Another use for one-time carbon paper has been developed by combining it with manifold to speed up letter writing by the typist (note our product "Copysette"). One-time carbon paper is used extensively in the manufacture of multiple copy teletype rolls. These rolls can be as many as nine parts.

It can be readily seen that carbon paper must lie flat, must have enough tensile strength to take the punching and perforating operations, and must have as much dimensional stability as can be obtained.

Base Papers Used in the Manufacture of Carbon Paper

Typewriter Carbon

The lighter basis weights of carbonizing tissues used in the manufacture of typewriter carbon papers are made from rags, hemp, flax, jute, or rope fibers. The 4 and 5½ lb. tissues are made in this country as well as imported from England they are of 100 per cent rag furnish, 6½ lb. can be 100 per cent rag or part rag and sulphite, 7 lb. and up can be part rag and part sulphite. Crane & Company manufacture only rag tissues and S. D. Warren and Schweitzer Paper Company manufacture the sheets with mixed furnishes.

Pencil Carbon

Most pencil carbons are of 100 per cent sulphite furnish and are manufactured by: S. D. Warren Co.; Peter J. Schweitzer; Brownville Paper Co.; International Paper Co.; Combined Locks Paper Co.; and Port Huron Sulphite & Paper Co.

One-Time Carbon

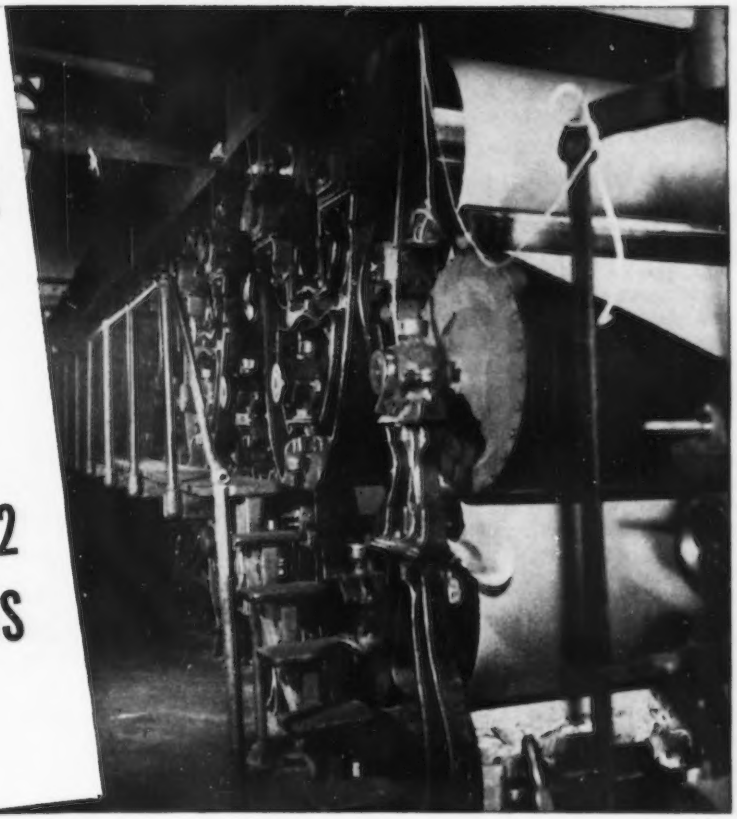
One-time carbonizing tissues are produced by: International Paper Co.; Peter J. Schweitzer; Brownville Paper Co.; and Port Huron Sulphite & Paper Co.

An idea of the quantities of carbon paper of various grades made in this country can be formed from reports that 1,700 tons of rag carbonizing tissue, 2,000 tons of sulphite carbonizing tissue and 23,000 tons of one-time carbonizing tissue were produced in 1952. It is reported that 37 tons of rag tissues were imported. These tonnages may sound very small to a paper manufacturer, but it must be realized that a box 8½x11 carbon paper will not weigh over one-half pound.

Quality of the Papers

Carbonizing tissues are made to very rigid specifications. Exact basis weights and calipers must be maintained. Sheets of very high density must be formed, tensile strength must be extremely high and particularly in the one-time carbonizing field where punching, perforating and tabbing is performed, the tear and mullen must be high. Low porosity must be maintained, and absorbency must be uniform so that inks can partially be absorbed by the sheet to form a good bond. Top quality pulps must be carefully inspected before use, hydration must be constantly controlled, testing procedures must be constantly checked and improved. Good uniform rolls without slitter cuts, felt hairs, or cracked edges, must be very carefully

FLINTKOTE ORDERS 44 MORE LUKENWELD JACKETED DRIERS AFTER FIRST 12 DELIVER BONUS OUTPUT



Lukenweld rolls now in 4 Flintkote plants

When The Flintkote Company wanted increased output of paper for roofing felt, they turned to Lukenweld Jacketed Steel driers.

In 1949, Flintkote added 12 Lukenweld driers to the dry end at its Lockport, N. Y. plant. The Lukenweld driers, 6 of which replaced ordinary driers, were designed to operate at 170-200 psi—three times the pressure of the old driers. No other expansion in equipment, no more plant capacity or space. Result: a 50% boost in tonnage on each Lukenweld drier.

Since 1949, Flintkote has re-ordered each year for its plants:

1950—a 10-drier section for Little Ferry, N. J.
1951—a 26-drier section for Mt. Carmel, Ill.
1952—an 8-drier section for New Orleans, La.

Proven performance is one reason producers like Flintkote invest in Lukenweld driers, either as individual units or complete sections. Lukenweld Jacketed driers can be designed to operate at pressures higher than 350 psi. Because they can't fail by shattering, Lukenweld driers are endorsed by the nation's leading insurance companies. You'll find, too, that the rolled steel plate of Lukenweld driers permits a shell 40 to 75% thinner than ordinary rolls, giving you faster heat flow, rapid heat-up and quick shut-down.

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wrapped and handled. The better grades of carbonizing tissues in the light weights must have resiliency or stretch so that they are not cut by the blows of sharp type on the typewriter or billing machines.

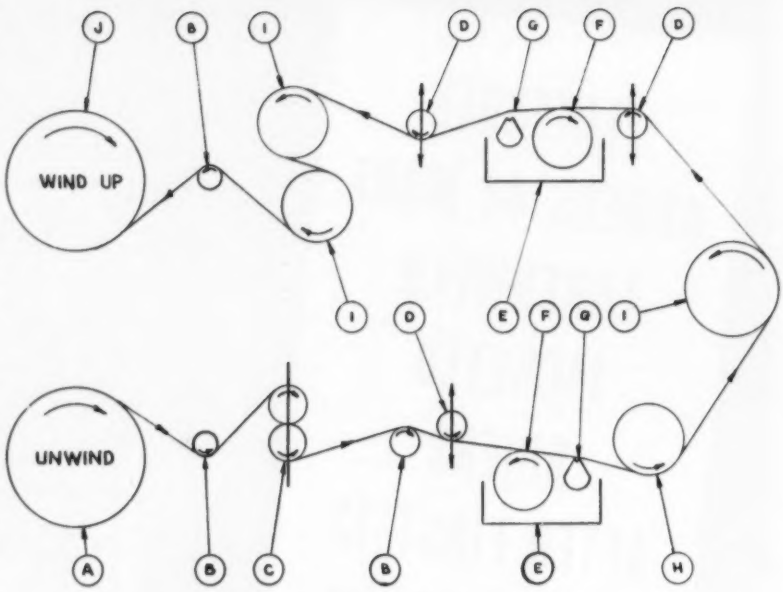
Materials Used

The original carbon paper manufacturers were forced to start a world wide search for a substance which would seal carbon ink into the fibers of a carbonizing tissue so that the resulting carbon paper could be handled without soiling both hands and letterheads and yet transfer readily into a clean and legible copy. Hundreds of substances were tried and discarded. Every known type of wax was tried and most found unsatisfactory. Carbon paper was dirty to handle and made illegible copies until the product of a certain palm tree that grew only in the jungles of North Brazil was discovered. The fronds of this palm are coated with a wax that has proven to be the only known substance that fits perfectly all the requirements of carbon paper manufacturers. This material is carnauba wax, and the tree is the carnauba palm. When the fronds have been dried in the sun they can be shredded and beaten to remove the wax. One carnauba palm produces about six ounces of wax per year, so it is readily seen that thousands of palm fronds must be harvested each year to supply the increasing demand for this wax. It was not until carnauba wax was discovered and added to the ink formula that carbon paper became a practical and useful article in the business world.

The properties of carnauba wax which now is indispensable to the manufacture of carbon ink are:

1. It has relative high melting point (180° F.) and never becomes tacky or sticky when cold. 2. It has the shortest fiber of any known wax and can be spread in an extremely thin film which is smooth and hard. 3. It has a dispersing action on the pigments which gives flow to the ink. 4. It has a strong affinity and acts as a solvent for dyes used as toners. 5. It has unusually high oil retention properties. These physical properties are exactly what are needed to form a thin hard film of ink not only on the surface but actually impregnated into the fibers of the paper itself so that it is clean to handle and produces a clean sharp copy.

Other vegetable waxes have since been discovered and now sugar cane, ouricury and candelilla waxes are also used. The carbon paper manufacturer also uses various mineral waxes such as paraffin and montane, animal waxes such as beeswax and sperm is also used. The oils used are mineral oil primarily but many non-drying oils can be used.



TYPICAL THREADING DIAGRAM FOR MAYER ROD TYPE CARBON COATER

Figure 1

Many preparations of dye-stuffs are used in the formulas for the various kinds of carbon paper. Aniline dyes of all colors are used. Pigments like carbon black, prussian blue, ultramarine and lake colors are all used. Fillers and extenders like chalk, talc, and clay, titanium and blanc-fixe are all used in varying proportions in carbon ink formulas.

Equipment

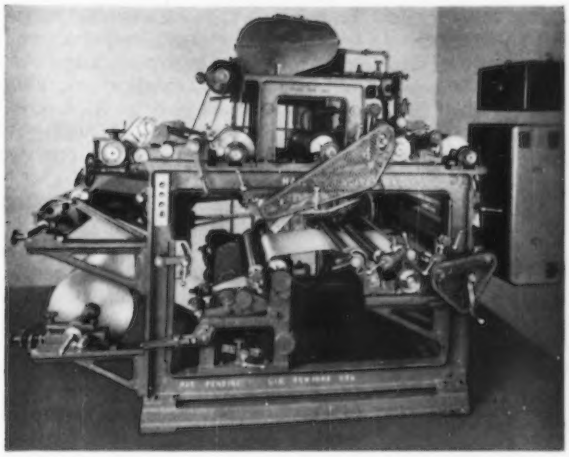
The basic equipment needed in the manufacture of carbon paper is ink grinding machines, coaters, sheeters and rewinders.

Ball mills are used extensively and the ingredients are all put into the ball mill along with a given quantity of steel balls and this mill is rotated on an axle for 1 to 16 hours. Roller mills are also used extensively in the grinding of inks, and in this process the inks are passed between polished steel rolls until standards of refinement are met.

Carbon coaters vary somewhat in design and are built to coat webs 30″ to 65″ in width. Speeds vary from sixty feet to a thousand feet per minute. They are equipped with stripping equipment which holds the ink off the desired section.

Figure 1 shows a typical threading of a Mayer rod type of carbon coater, which is the principal type used in this country. The raw stock or uncoated paper roll "A" is provided with a brake which resists the unwinding of the sheet which is used only to prevent the roll from running away while the sheet is being delivered to the infeed rolls "C" with as light tension as possible. The infeed rolls are provided with a braking devise which holds the sheet back against the pull of the figure "8" arrangement of the chill rolls "I." By varying the braking force of the infeed roll the tension in the sheet between infeed and figure "8" rolls is complete. The sheet then passes over the dope roll "F" which is turning against the travel of the sheet flooding it with an excess of carbon which is removed by the Mayer rod "G." The Mayer rod removes the excessive ink and meters the balance on the sheet. After leaving the Mayer rod the sheet passes under the foot roll "H" which may be either hot or cold depending on the characteristics desired in the finished product. The chill roll sets the ink. If a double faced coating is desired the opposite side of the paper is coated in the second coating unit. The second and third chill rolls, with the figure "8," not only provide an outfeed lockup but insure good coating which will not be tacky when it is wound up. The windup roll is powered by one of several devices which turn under constant horsepower and draws a constant tension in the winding up of the roll.

The sheeters used for carbon paper are usually of the collapsible reel type. Bear in mind that carbon paper cannot be jogged so it must constantly be held under control and this type of sheeting



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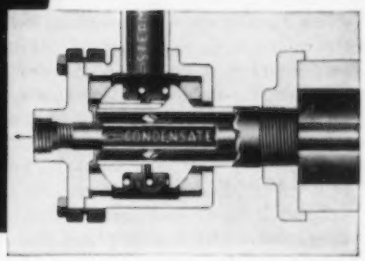

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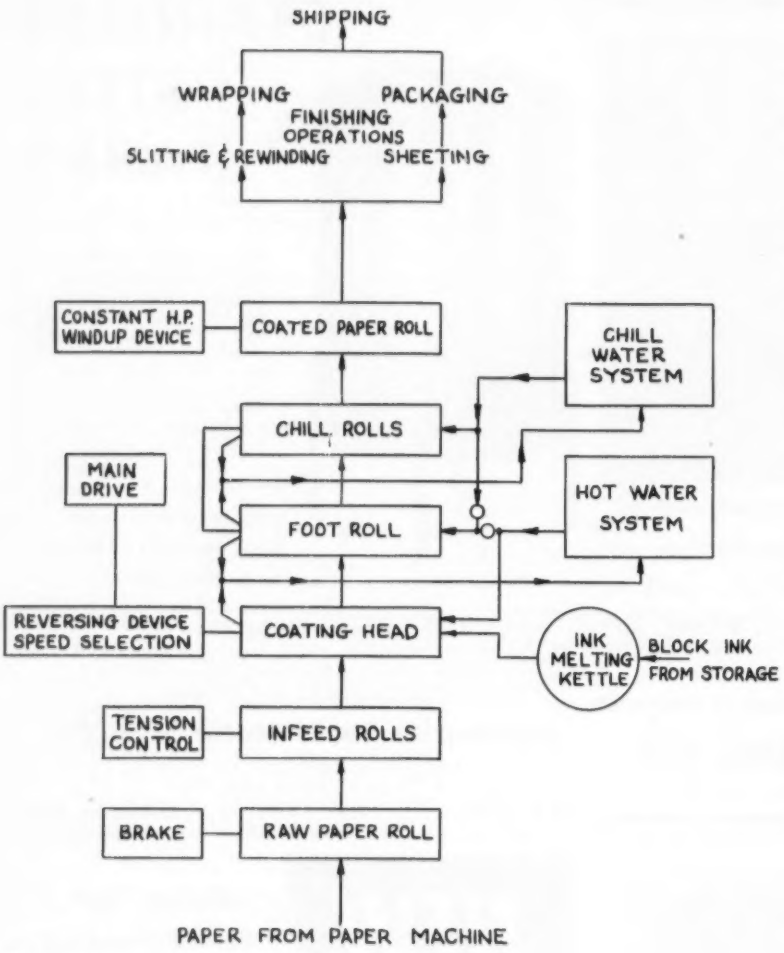

Figure 2

equipment has been the most successful to use up until the present time.

The manner in which carbon paper is rewound is most important. It has been found that center shaft winders will give a roll that is firmly wound but not so hard and tight as to cause undesirable offset.

Manufacture

Figure 2 shows the normal flow of paper, ink, controlled hot and chilled water through a typical carbon plant.

An ink formula may call for as many as 20 ingredients and the first step in ink manufacture is the careful weighing and measuring of each component in the exact quantity specified by the formula. This is a most important operation as a slight variation in the proportions can entirely alter the physical characteristics of the ink.

When the ink has been thoroughly blended by hand it is heated to melt the waxes and then poured into a heated ball mill. The ink mixture is thoroughly pulverized and all lumps reduced by the tumbling balls in a matter of hours. Ink for high grade typewriter carbon papers are then transferred to a heated roller mill where it is passed through a series of large steel rolls revolving at unequal speeds until the pigments are ground into such small particles that the ink has an extremely smooth texture. A batch of 80 pounds of ink may take from 4 to 9 hours to be completely prepared in a roller mill. The inks are usually made well in advance of their use and are usually taken directly from the ball mill or roller mill and put up in cakes for storage.

When the inks are to be prepared for the coater the cakes are melted in melting kettles with temperatures between 180 and 200 degrees. After the ink is thoroughly melted and mixed it is pumped to pans on the carbon coaters. These pans are steam jacketed to keep these inks at exact temperatures, which are normally 180 to 200 degrees.

To control the amount of coating on the various carbonizing tissues Mayer rods of various diameters are used. Plain rods will vary from 1/16 in. diameter to 5/16 in. diameter. Wire wound rods are also used having .004 to .016 wire carefully wound around a plain rod. Some grades of carbon paper will have up to 9 pounds of ink, others, such as one-time may go to 2 pounds of ink on a ream basis of 20x30—500.

One of the most important functions of the carbon coater operator is to keep the hot rolls and the chill rolls at the specified temperatures. Most carbon coaters are equipped with mirrors so located that the operator can see exactly how the sheet is being coated.

The process of coating carbon depends on the inks, paper, the temperatures of the ink, the temperatures of the hot and chill rolls, the size of the Mayer rods and the distances between rolls.

Carbon paper is different than many other papers that are coated in that they improve with age. It is believed that this improvement is due to a change in the crystalline structure of the wax. The better grades of typewriter carbon papers are aged for at least three months before they are put on the market.

Testing Carbon Paper

Carbon paper is made in a great many grades, degrees of intensity, shade and thickness as has been outlined. The carbon paper salesman offers the buyer a wide choice and the buyer usually designates his or her requirements on a personal preference basis.

The only standard testing procedures are those set up for the Federal Specifications. These specifications say the first two things to consider in connection with testing carbon paper are the fiber composition of the tissue and the weight of the tissue after the coating has been removed. These may not have a direct bearing upon the writing qualities of the carbon paper but are intended to eliminate tissues of inferior quality.

1. The fiber composition is determined microscopically with the aid of suitable staining agents which help to distinguish betwen fibers of different kinds. The coating can be removed from a small piece of carbon paper by means of carbon tetrachloride, benzene, or other solvents for wax and oil.

2. Writing tests, wear-down or manifolding, are made on typewriter carbon. The wear-down test gives an idea of the number of times a sheet of paper can be used before the coating is worn off. The manifolding test shows how many copies can be made at one time. Both of these tests leave it very much to the judgment of the tester on whether quality is satisfactory or not.

To make the wear-down test a piece

of carbon paper about 1x2 inches is fastened, coated side out, to a sheet of paper used for the first or ribbon copy. The carbon paper can be fastened by means of a piece of gummed label or adhesive tape. The sample so prepared and a sheet of thin manifold or copy paper are put in the typewriter in the usual way. The sheet carrying the sample is fastened by means of clips to the back of the carriage in such a way that the carbon paper will not move when the platen is turned to shift the manifold sheet a single space line. Before the writing is started the platen is given a single turn so as to pull taut the sheet that carries the carbon paper. A line of "G's" is then typed across the piece of carbon paper, the carriage is returned to the starting point, the platen is turned to shift the manifold sheet a single space line and other line of "G's" is typed across the same part of the sample as before. All this is repeated until 4 or 5 more than the required number of lines have been typed. According to Federal Specifications standard weight carbon paper must write at least 15 legible lines of good intensity. The lightweight paper must write at least 12. In order to favor the carbon paper as much as posible, Federal Specifications say that the electromatic typewriter, which is used for testing, should be run at a low speed so that the type will not hit the paper very hard. It is felt that if a sheet of carbon paper will make 12 or 15 satisfactory copies in this type of test it can be used many more times in actual service as there is not the same exact register of lines in normal typing.

To make the manifold test a sheet of letter paper for the ribbon copy and the required number of sheets of manifold and carbon paper are assembled in the usual manner and put in the typewriter. For obvious reasons the typewriter must be run at such a speed that the type hits a comparatively hard blow. Standard weight carbon paper must make at least 5 legible copies of good intensity and lightweight paper must make 10 copies.

Pencil Carbon

There are no Federal Specifications covering pencil carbon paper, but a test has been developed whereby a sample of pencil carbon paper is fastened to a sheet of letter paper so that the carbon paper will come in contact with the second sheet in the usual way. A small ruler and a stylus is then used to draw 20 lines in exactly the same position on the carbon paper with the copy sheet being moved to show the wear quality. The stylus is held in a clamp so arranged so that it can be weighted. One set of lines is drawn with a total load of 150 grams on the point of the stylus and another set with a load of 450 grams. It will be found that two samples may closely match at one load yet be quite different from one another at the other load. Naturally the sample which gives good results at both loads is the one to be preferred.

One-Time Carbon

Testing of one-time carbon paper consists primarily of manifolding tests and many forms today are being made with as many as 18 parts.

Rigid standards are set up by each manufacturer and electromatic typewriter and pencil write tests are made on samples from each jumbo roll as it starts up on the carbon coater. Slight variation is tolerated from roll to roll and unusually high standards are maintained in this field. It will be appreciated that one-time carbon is a small part of the cost of many part forms and many of these forms are in storage up to five years time. One-time carbon paper is what the name implies, made for one use, and therefore the formulas, the paper, and the coating process must all be geared to a release of most of the coating with one use.

Troubles Encountered in Manufacture

Many troubles are encountered in the manufacture of carbon paper due to the condition of the jumbo rolls of raw stock. Wrinkled raw stock must be culled out, cracked edges, which are encountered usually in the manufacture of lightweight tissues, can cause breaks on the coaters. A variation in caliper of the raw stock which forms hard and soft rolls are most troublesome and can cause a variation in the pick-up of ink. Offset can easily develop, particularly with the softer intensities. Bear in mind that every time a coater is stopped, defective product is made and must be cut out. Storage of carbon paper, particularly in roll form, is most difficult because it is so fragil. Stretch on one side of the jumbo roll can cause much difficulty for the eventual user in roll form. Trueness of the white edges and stripes must constantly be checked for accuracy. Temperatures must be controlled, and if by any chance they drop below normal, a heavy coating is deposited on the tissue and this will flake off the minute the coated tissue is handled. On cheap grades of one-time and carbonizing book and news bleed-through of the ink to the reverse side is most disastrous. Atmospheric conditions will greatly affect the raw stock and the finished product and must be controlled.

Selling of Carbon Paper

The large manufacturers of typewriter carbons, pencil carbons, and typewriter ribbons have set up large national distributing arrangements for their products. Many of these concerns have a sales office in every major city and have a large force who sell their complete line to consumers both large and small. Some salesmen in New York City will spend most of their time going from office to office in a large building like the Empire State building. Every merchandising device ever thought of has been tried by these people.

Other large producers of these items have worked exclusively with stationers stores that they have franchised to handle their products.

There have also been some very successful brokers in the distribution of carbon papers and ribbons. This is a very competitive field and if a salesman is successful in this field he can make a very attractive income for himself.

The sale of one-time carbon paper is usually handled as a direct transaction between the manufacturer of the one-time carbon paper and the forms manufacturer. The success or failure of a multiple copy form hinges to a great extent on the use of the proper grade of carbon paper to fit all of the requirements in the users office or factory. Sheet one-time carbon paper, pencil carbon paper and sheet carbonized book also are often sold through the paper merchant to the flat bed printers.

The manufacturer of one-time carbon paper goes to great lengths to see that the forms manufacturer's sales offices are equipped with fresh samples of all of the formulas as coated on the various weights of tissue. These samples are used in the making up of dummies of the exact number of parts and weights of paper so that approval of the carbon can be secured by write tests made under the exact conditions in which the forms will be used. Most carbon paper manufacturers make recommendations of which carbon should meet the average requirements.

One-time carbon paper is priced in several ways. Jumbo rolls can be sold price per 100 pounds, slit rolls can be sold either price per 100 pounds or price per unit, which on this grade of paper is considered a strip 1" wide 1,000 feet long or 12,000 square inches. Sheets are usually sold price per ream or price per thousand square inches.

Crepe Paper and Creping Machines

Horace C. Baker

Sales Engineer, Hudson Sharp Machine Co., Green Bay, Wis.

The paper that I have prepared for this evening, is based upon a period of years of selling paper processing and paper converting machines. I have not tried to make it a technical report, nor an engineering description. It is based upon experiences in meeting superintendents, engineers, production men, purchasing agents and by all means of close contact with people who are producing paper products that have added something to better business and better living.

The origin of creping paper is somewhat vague. However, the early reports of this product and the description of the creping equipment point to German paper processors. The old reports on the subject, which I found in the excellent library of the Institute of Paper Chemistry at Appleton, Wis., were printed in German and the English versions are listed as translated from German authors.

Undoubtedly the first production was an accident following the breaking of a web in a paper machine. Because of the break the sheet was retarded and it landed in the broke box with a crepe finish. I can picture the German paper maker who found the sheet, visualized its utility and thereby created a new use of paper. We do know that the process of creping papers was not applied at once to the paper machine, but was used on a machine particularly designed for the purpose.

A study indicates that crepe paper, as produced today, has five different processes with five different methods of its production listed as follows:

1—Special type creping machines.

2—Dry creping machines, where no water or moisture is used in the production.

3—Semi-creping in paper machines.

4—Crepe production on a machine which will crepe and in the same process, laminate the web to another sheet of paper. The laminating adhesions are usually hot asphalt.

5—Embossing equipment, which produces a coarse, low stretch crepe.

Horace Clifford Baker was born in Little Suamico, Wis., May 13, 1891. He attended grade and High Schools at Menominee, Mich., at which time he was apprenticed and worked as a printer in shops in Menominee, Mich. Worked as journeyman printer in Kalamazoo for three years while attending Kalamazoo College. Returned to Menominee as a news reporter, was at the City desk at the daily news paper in Marinette, Wis. and a desk man on the Green Bay Press Gazette at Green Bay, Wis. He has been with Hudson Sharp Machine Co., Green Bay, Wis. for slightly over thirty years in publicity and sales. At present in charge of sales for export of the same company.

We will start with the first process, viz. the use of a special machine designed particularly to make a full creped sheet. The raw material will be one of many types of finished paper which will be fed from a parent roll. The sheet will move into a water bath. The volume of water that will enter the sheet is based upon its time in this bath and the regulation with toggle rolls that will carry the sheet into the tank and lead it out to the creping cylinder. In most cases, the wetting tank carries heated water and contains glues or sizes that are dissolved in the bath to provide a stiffness to hold the crepe percentage in the sheet after it is dried. The sheet is then carried, with some tension, to a heated creping roll.

The creping blade is located horizontally across the surface of the roll, just before the point where the sheet would normally leave the roll. The blade oscillates slowly back and forth. The edge of the blade is beveled and the blade is provided with adjustments to tilt the edge at from 20 to 30 degrees. The depth of the crepe is based upon the adjustment of the angle of the blade contact. The creped sheet is then carried over the doctor blade and it is picked up by a series of driers where the sheet is dried and rewound.

The speed of the driers is based upon the percentage of crepe that is to be preserved in the finished sheet. In most cases the actual crepe leaves the creping blade with considerably more stretch than is required and the drier section is operated at a speed that will take out the overrun of creping, before the sheet is rewound.

Drum rewinders are not used for the coarse crepe, but they can be used for semi-crepes that are produced on the paper machine. The early creping blades were bronze but the modern blade is steel. The blades must be changed regularly and they are carefully ground with the desired bevel. Decorated or colored crepe is produced by the addition of a dye in the warm water bath, at the creping station of the machine.

Dry Creping

There are several types of dry creping machines, but all the processes in use are based upon moving a dry sheet of kraft through steel creping fingers. The fingers are held about one inch apart longitudinally across the machine. The fingers are placed above and below the sheet and they are tilted to form a wedge with an adjustable opening at the delivery position. Endless belts are located between the crep-

ing fingers below and above the sheet. The web is drawn into the small opening in the wedge end and the sheet is delivered with a crepe finish. The product does not match the product that is made on a standard creper. The fingers mark the surface and care must be taken to hold the fingers to a perfect adjustment or they will tear small holes in the web.

Semi-Creping in Paper Machines

The third type of machine uses perhaps the most popular process for producing creped paper. It is used for high production and the process is tied in with the machine that produces the paper. In operation the sheet is formed and partially dried and delivered to the creping calender at a point where the sheet has lost a considerable amount of moisture. The creping calender carries the same speed as that applied to the paper machine driers.

The creping blade used is similar to the blade used for the standard creping machine. The pressure of the blade is adjusted with weights. The blades are longer than the units used in the standard machine and some of the recent machines producing napkins, toilet paper, paper toweling and facial papers are processing a web 160 inches wide.

The production is high with speeds varying from 1000 to 2500 f.p.m. A new machine of this type for the production of paper wadding, is now operating at the speed of 2500 f.p.m. and it is claimed that it will eventually reach a speed of 2800 f.p.m.

The crepe produced is fine and the stretch is low. However, the semi-crepe produces a soft sheet and provides considerable bulk in the rolls converted into finished products. The products made from this type of creped paper are versatile and numerous.

Buyers in this country refuse to use the old cylinder sheet for toilet paper. Foreign countries are still using the cylinder sheet, but new equipment is going into England, the Scandinavian countries, South America, South Africa, Australia, Mexico, which will produce good semi-crepe.

Semi-crepe is used for paper napkins because of its softness, but also because it is ideal for embossed designs. The embossing adds to the bulk of the napkins and a package of 50 units has the appearance of at least one hundred napkins of ordinary semi-crepe. I have personally witnessed a buyer who had picked up a pack of 40 high bulk napkins, when a package of lower bulk with more units was overlooked.

Facial tissue papers used in the original size, pocket packs of facial tissue, handkerchiefs, and napkins with one to three plies, are turning up enormous totals. One of the larger paper producers of facial tissue toilet rolls, is tripling its present production.

Present users of our converting machines are continually at our door asking for faster and more fully automatic machines.

Creping Laminated Papers

Asphalt is usually the laminant used for water proof crepe papers. Some of the paper is laminated before the creping is accomplished and other processes call for the laminator to follow the creping. The process of creping is similar to that used in coarse kraft sheets. The lamination of the sheets must be carefully considered in either of the applications. The asphalt must be applied extremely hot to provide a fine film applied to the sheet. An over-run of the asphalt in the sheet will crystallize and will crush or break in rough use.

Some processors have two machines, one to laminate and the other to crepe. We have built machines where the lamination was completed and the sheet carried into the creper with all of the equipment straight lined.

Some converters have applied crepe to the sheet and then led it to a laminator where the crepe is laminated to another sheet, to produce a corrugated face on one side and a flat finish on the other.

Some recent developments include latex as a laminant and in a creping process. The latex will remain more or less soft after the lamination. The sheet will respond to the creping machine and the product is used for waterproof protection.

Masking tapes and similar products have a simple method of creping which will give them the stretch in the sheet desired. The adhesive is applied to the sheet and the sheet is picked up by a roll with the sticky side down. The creping blade is then applied to the roll, which will crepe the sheet, and provide plenty of stretch.

Embossing

The last method of creping is that of the use of an embossing machine. No doubt, you are all informed as to the embossing machine and embossed papers. The machine has a steel roll and a paper filled roll. The sheet roll is engraved with a selected pattern and is referred to as a male roll. The paper roll is known as the female roll and the pattern from the male roll is forced into its surface. The process will give some stretch to the embossed sheet but it also cuts the strength of the web to a certain degree. For coarse papers the steel embossing roll is engraved with lines across the roll with perfect reproducing of the water creped kraft designs.

Producers of toilet papers are placing wide embossing units operating against a papier mâché filled roll, to use a linen design to crush fiber and to add to the softness of the sheet.

Use of Crepe Paper

The next question naturally is "What do they do with a creped paper?" "What has brought about the increasing volume of its use?" I perhaps can tell you a little story which will explain some of the new demands.

During the last war when the armed forces could not obtain natural rubber and a synthetic substitute was devised, a problem arose in boxing it. They first decided to put it in a corrugated box in batts of approximately twenty-five pounds. The sheet of latex was run through a pair of pressure rolls for its final finishing. The rubber came out in a thin sheet which was removed from the roll by a doctor blade. The rubber was dropped in the box with the sheet lapped until the proper poundage for each container was obtained. The boxes were sealed and placed in a warehouse. The rubber in each box had considerable weight and gradually the rubber stretched to a point where the thickness of the contents of the box was cut down as much as two inches. The boxes that were piled in warehouses could not carry the weight and popped open. There was a meeting to find a safe method of handling and they finally wrapped the batch of rubber in a wrap with asphalt laminated heavy crepe. The rubber worked down until it found its level and the paper stretched to meet the pressure at the sides and ends without breaking the wrap.

Wrapping Machines

Machinery boxed for export is usually treated with a corrosion protective coating. To make sure that the salt air will not circulate in the case and find a spot that was not treated, creped papers laminated with asphalt were wrapped around the machine as a secondary protection against corrosion.

The growing demand for new wrapping machines and wrapping material to be used in the machine is such that wrapping machine manufactuers are asking for all types of protective papers. Some of them are using the new type films, or are using waxed papers, but others are asking for a wrap that will stretch and the ideal answer is creped papers.

Manufacture of Wallpaper

R. L. Boyd

Vice-president, United Wallpaper, Inc.

The History of Wallpaper

The desire for patterns on walls goes back to the caveman, who scratched scenes of the hunt on the walls of his shelter. It is quite a leap from the cave man to the advanced Chinese civilization of the 13th and 14th century, but early explorers found the Chinese were not only very fine artists, but they found examples of the first wallpaper. These were made in the form of scrolls and were, therefore, portable and could be moved from place to place. Of course, the individually painted, scenic type of scrolls were exceedingly expensive and, therefore, available only to the nobility. It wasn't until after the invention of printing and the publication of the Gutenberg Bible that the Europeans learned to print fabrics, or wallpaper. Up to this time, when any of the nobility wished to decorate their homes, they were forced to use woven scenics or tapestries, damasks, or brocades.

With the invention of printing, it wasn't long before artists devised a way of printing paper, and the first designs were what we now call dominoes. These were small patterns and were printed on sheets such as marble-ized papers are printed today. Many of the first floral and damask papers were printed in outline only, with what we call the binder technique, and the color was applied later by hand. These print blocks were cut by hand from wood and still in those days the finished product was none too cheap. However, the printed sheets were a great deal less expensive than brocades, and when the fine artists, such as Reveillion, designed scenic or floral papers, they were in great demand by the nobility.

R. L. Boyd, Vice-President in Charge of Operations with United Wallpaper, Inc., has been in the wallpaper industry for 30 years. He started as a helper and quickly became a Color Mixer, following in the footsteps of his father and grandfather. He received his formal education at De Paul University High School and Northwestern University. Among his business activities during the last 10 years has been active participation on the Labor Relations Committee of The Wall Paper Institute.

During World War II he handled the production operations of several plants manufacturing incendiary bombs, parachute flares, and other types of pyrotechnics for the armed forces.

With the industrial revolution in 1830, machinery was harnessed to manufacturing. Wallpaper manufacturers, following the style set by the nobility, who used handwoven silks on their walls, began to make wallpapers to obtain the same look these silks had, and we still make papers today that we call damasks and brocades, using these simple classic motifs for our inspiration.

As time went, wallpapers became more beautiful; in fact, many of the fine examples of early hand blocked patterns have never been surpassed. One of my most interesting experiences was during a visit to a designing studio in Berlin in 1949. They had been fortunate enough to obtain a collection of over 5,000 hand blocked prints from a wallpaper concern in Bavaria, who were closing their business. These were prints over 100 years old and were the product of the finest artists of that day. I needn't tell you they furnished the inspiration for many designs for our Company, and I mention it to show you that we can be proud of our heritage as an industry. All during the years, it has attracted the best in art, up to the present day. That is true except for the time during the Depression of the late thirties, when good design fell off considerably.

Thus we may trace the manufacture of our product from hand blocked binder patterns, which were later completed by hand painting, then to hand blocking of complete designs, some of which contained as many as a hundred colors and may be seen in some of our great museums. As a tribute to the

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skill of those artisans, the color and quality of those specimens are beautifully preserved. Next came the rotary multiple colored printing machines, utilizing techniques acquired in hand blocking in roller form. The method of cutting or routing was so closely followed that we still call our rollers "blocks". This first machine printing was done on the Continent in 1840, and it was not until shortly after 1850 that the first machinery was brought to this country. By 1890 there were almost two dozen fair size wallpaper manufacturers in the Greater New York area alone.

Distribution and Sales

In our country today, there are approximately forty manufacturers of varying size. The annual production averages about 250,000,000 rolls. Like many products, there is no standard pattern of distribution in the wallpaper industry. Some manufacturers, like ourselves, sell through distributors who in turn sell to dealers, who then sell to the decorating contractors and the retail consumer. There are other manufacturers, mostly the smaller ones, who sell directly to the dealer, and there is one large mail-order house who manufactures its own wallpaper and sells directly to the consumer.

The purchasing habits of the consumer have very materially changed over the last twenty years. Up to that time, the greater majority of wallpaper was purchased in the home from sample books submitted by the paper hanger. Surveys today indicate that approximately 80 per cent of the wallpaper is either purchased or selected in a retail establishment of some type.

In keeping with the changing habits of the American consumer, and also the necessity for proper merchandising of products in today's competitive market, our Company has just recently designed and distributed the new wallpaper merchandising unit known as The Decorating Center. This unit was designed after extensive surveys of the habits and needs of the wallpaper buying public had been made. One of the important disclosures was the fact that 91 per cent of the purchasers of wallpaper had a predetermined definite color scheme in mind before starting to shop. The Decorating Center is a completely coordinated selection of wallpapers in a broad price range displayed by background color groups. Equipped with indexing, decorating guides, and color and pattern references, it is proving not only a great aid to retail sales personnel but has tremendous potentials toward "self-service" buying.

Raw Materials

Normally, when we think of wallpaper, it does not occur to us that a great number of raw materials are used in this industry. Aside from the raw material that goes into the make-up of the raw paper stock itself, materials that seem strange to the finished product are actually very vital to it. Coal, lead, zinc, silver, aluminum and brass are used in the manufacture of the color. Wheat, corn, soya beans, potatoes, etc. are used in the adhesive that bonds the color to the paper. Iron oxide is one of the less expensive color bases commonly referred to in the industry as "box car" red because of its similarity to that shade.

Kaolin clay is delivered in carload quantities from the State of Georgia. This type of clay is very similar to the coating clay used in the paper coating industry and is purchased in the largest volume of all pigments. It is found in deposits very near the surface of the earth and is mined by the strip method.

The clay is washed and dispersed and then goes to huge driers which remove the water from the clay, leaving approximately 4 per cent moisture, which incidentally, is sufficient to keep the dust down in handling the clay.

Other white pigments used in quantity are titanium dioxide, lithopone, and zinc oxide, each having its own value as a hiding or opaquing medium.

The adhesives used most generally for binding washable wallpaper colors are casein (for the most part imported from Argentina) and isolated soya bean protein. Starch is still being used in the manufacture of the cheaper non-washable papers. Although some work has been done recently in developing a washable starch, very little is being used in this country; however, in Europe nearly all of the limited number of washable sheets (practically all of which are for export to this country) are being made with the urea formaldehyde treatment of modified starch. We find this type of adhesive to be short and weak, and it does not give good opaque printability demanded of our manufacture.

At this point, it would be well to explain the generally accepted meaning of the term "washability" in our industry. "Washable" wallpapers are washable only in the sense that they may be sponged with a mild soap solution without removing the colors. In other words, washable wallpapers are coated and printed with colorings which are insoluble in water and have some resistance to scrubbing.

The standard method of manufacturing washable wallpaper in this country is to use these protein types of

Each of the colors in a pattern is printed from a separate block or roller. The block-cutter shown here is preparing such a block using strips of brass and sometimes pieces of felt which are pounded into the surface of the hard wood cylinder which is the block. A very exact and highly skilled craftsman, the block-cutter is a vital factor in the making of any wallpaper.

sizing and then to subject the printed paper to a bath of alum or formaldehyde or both, varying the amount of sizing to pass a given wash test. Basically, in order to use these proteins, it is necessary to put them into solution with an alkali. The alum or alum-formaldehyde reconverts the protein to its original water insoluble form. There are controversial opinions on whether an additive compound is thus formed or a substitive product, but in any case, the result is one of water resistance.

Wallpaper manufacture involves the use of both organic and inorganic colors. The organic colors are essentially derived from the reaction of chemical compounds. In this classification we use naphthols, madder lakes, phthalocyanines, and pigment green. Twelve different colors are used; four reds, two blues, three yellows, green, black, and brown. These colors are particularly chosen for their stability in the presence of alkali, which is encountered in the adhesives, and in certain conditions found in walls over which the paper may be hung. Other important features necessary in these colors are resistance to fading from exposure to sunlight, discoloration due to the lack of sunlight, and stability in the presence of heat encountered during the drying process and behind radiators, etc. in the home.

Our Company makes all its wallpaper colors in the strongest possible tones. The color is then extended with inerts, such as barytes and aluminum hydrates, using a very carefully balanced formulation to give the utmost in economy, ease of mixing, proper adhesion, and washability.

Material Preparation

Various types of mixing equipment are used in preparing the raw materials for use by the color mixers. Large clay dispersing units 2,000 gallons in capacity are used in the United Montgomery plant. These huge mixers are capable of turning out 2,000 gallons of finished clay every hour. The clay is dispersed in these mixers, anti-foams and adhesives are added, and the entire batch is then pumped to a water jacketed tank, prior to being pumped to the color mixers.

The temperature of this clay is controlled so that viscosities will remain constant. This clay mix is the white used in all ground colors. The strong colors used for tinting and all printing whites are ball milled 8 to 16 hours. Once these staining colors and printing whites have been ground, they are drained into portable tanks that have continuous agitation.

Mica is used to create the silvery effect on backgrounds. To wet out the mica properly, heavy duty dough mixers are used. This same type of mixer is employed in wetting out aluminum and bronze powders.

When the mixing cycle has been completed, the color is checked by the control laboratory. Four basic tests are made: viscosity, pH, shade, and washability. The pH control is a very important one in the wallpaper industry, as a slight tapering off in pH indicates the protein is not only losing its strength but is liable to spoil.

Very slow moving stain colors are stored in the mixed state for as long as three months. This is an unusually long time for a protein type color, and it is by constant pH control that we are able to keep this color usable.

In the Montgomery plant, the clay ground color is pumped over ¼ mile to the ground mixing room. There it can be diverted into one of 48 600-gallon tanks. These tanks are equipped with hot and cold water, as well as steam. While one tank is being used, the adjoining tank is thoroughly cleaned and steamed. When the tank is spotless, it is ready for the next color.

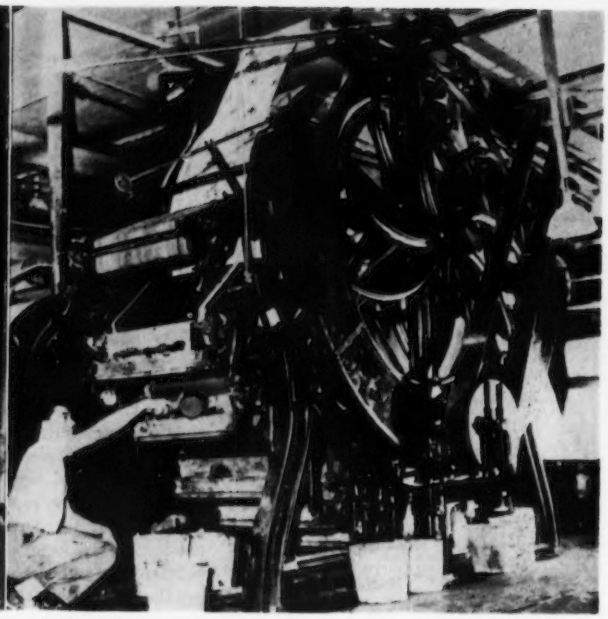
The color mixer takes over at this point, computing the proper gallonage and mixing the stains and the clay white to arrive at the proper shade. The same procedure is followed by the top color mixer, who shades the printing colors, with the exception that he has three different whites to work with, ranging from low cost filler clay to titanium pigment. He obtains the balance of color and coverage by proper use of these pigments.

It is interesting to note at this point that, because of the many variables in the raw materials used in our colors, no shade formulations have ever been successful; thus, all of our shading is done by matching colors by the trial-and-error method. Many of these craftsmen develop amazing skills that enable them to match a given color with speed and accuracy.

Printing Rollers

When a design is selected, it is turned over to a block cutting shop for roller making. A complete tracing of the design is then made on a specially treated paper with a fine scribing tool. The fine lines of this tracing are then filled with an oil and graphite solution, which is then transferred onto seasoned hard maple or aluminum alloy rollers. A separate roller is provided for each color. Brass strips are then driven into the wood, forming an outline tracing the portion of the pattern that the roller is to print. Large printing areas are then filled with a specially treated felt. These brass outlined forms are approximately ¼ inch in heighth. In the case of

In the "ground" room at the new United Wallpaper plant at Aurora, Ill., the ground (or plain background) colors are mixed and sent down to the printing machines. The raw clay comes in through overhead pipes and the ground-color-mixer tints shades needed for a particular pattern. Temperature in this room is kept fairly constant in order to maintain an even, liquid flow of color. A sudden change in temperature will sometimes affect the viscosity of the liquid color.



While the prinitng machine is stopped momentarily, an apprentice fills color into the color "sleeve," the trough that holds the color mixture. Present day machines can accommodate patterns with as many as 12 colors in them. The machine itself revolves at great speed, and each color falls "wet" in its exact position on the background color. Lower right shows the plain paper entering the machine, and top center shows the completed design.

metal rollers, the design is put on what is to become the printing surface, and the non-printing surfaces are routed away to a depth of approximately ¼ inch.

Thus, the finished set of blocks or rollers may consist of up to thirteen, each representing a different color, which are keyed in such a manner that they may be placed in one printing machine and indexed to print the finished pattern in register.

Grounding

Originally, the first or base coating on wallpaper was applied by means of handbrushes, and the sheet was dried prior to the application of the multi-colored pattern. The first mechanical coaters were similar to the brush coaters used in the paper coating industry in general—the main difference being that they were smaller and were built to be washed quickly, due to the frequency of color changes.

In recent years there have been several other coaters developed, including roll coaters, reverse roll coaters, vacuum coaters, and air knife coaters. Our mills are equipped throughout with air knife coaters, having a total of approximately 60, varying in width from 20-inch to 40-inch.

We have found, in our case, that the air knife coaters do a splendid job, producing grounds much superior to those that we have obtained with any other type. At the same time, the maintenance cost is much lower and make-ready faster.

The principle of this type of application is as follows: the web of paper is fed through a tensioning device across a color feed roller. This roller revolves in a reservoir, which applies color in excess of that required. The paper is then drawn around a breast, or backing, roller by means of a revolving suction belt. At this point, the entire face of the sheet is subjected to a controlled flow of air from the orifice of the knife mechanism. This removes the excess color, which then flows back to the reservoir. With this type of application, the weight of coating applied per ream can be controlled quite accurately.

With the development of lightfast colors in the late 20's, it became evident that there were two factors involved in the development of a fade resistant wallpaper. One was the color itself and its particular quality as far as resistance to light was concerned. In cooperation with color manufacturers, it became possible to produce lightfast colors. Secondly, it was found necessary to get a sufficient coating or coverage on a paper, so that fading or darkening of the raw stock would not be a factor. With the conventional type of clay, it has become the practice to use 16 to 20 lbs. of coating per ream. The deeper the coloring of the ground the less coating weight is required.

The basic mechanical controls on grounding or coating are the weight of applied material and Fadeometer evaluations.

Drying

After the sheet is "grounded," it is passed through a festoon dryer similar to those found in specialty coating mills. These dryers vary in length from 70 to 250 feet. While some few flat pass dryers have been built, the basic method is still festooning. Practically all of the drying in the industry is done with steam heated air. This drying process is repeated after printing and again after hardening, or waterproofing.

Printing

The paper now having been grounded and dried, the next step in its manufacture is printing. The printing process is basically rotary printing on a single cylinder, or drum. The majority of the machines in use today

Battery of air knife coaters in plant of United Wallpaper Inc., at Montgomery, Ill.

print 12 colors, although there are some 8 and 10-color machines in use. These machines are equipped with cylindrical printing beds of approximately 8½ feet in diameter, which are heavily wrapped with cloth. The web is drawn around this drum, under guide and tension. Each of the 12 color stations is equipped with ink fountains and registering devices, similar in principle to those employed in any type of rotary printing, the basic difference being the color, or ink feed system. The ink is fed from a reservoir to the print roller by means of a continuous belt of woven wool, or sieve cloth, which is doctored by means of a brass or fiber blade. The pressure between print roller and printing bed is very light. Good printing is obtained more by color feed than by pressure.

Other methods of printing used in a limited way are Rotogravure and the so-called sanitary, or engraved, processes. These represent less than 2 per cent of our total production.

Hardening

The paper is now dried once more and sent through a squeeze roll coating device, a simple machine which submerges the grounded and printed web in a hardening solution. The excess is removed by passage through a set of rubber squeeze rollers. At this point, the sheet receives its final drying.

Finishing

The product is now ready for the finishing process. Some style are embossed on rotary embossing machines. Others are calendered or rolled flat. Both automatic and semi-hand rolling are employed in the industry.

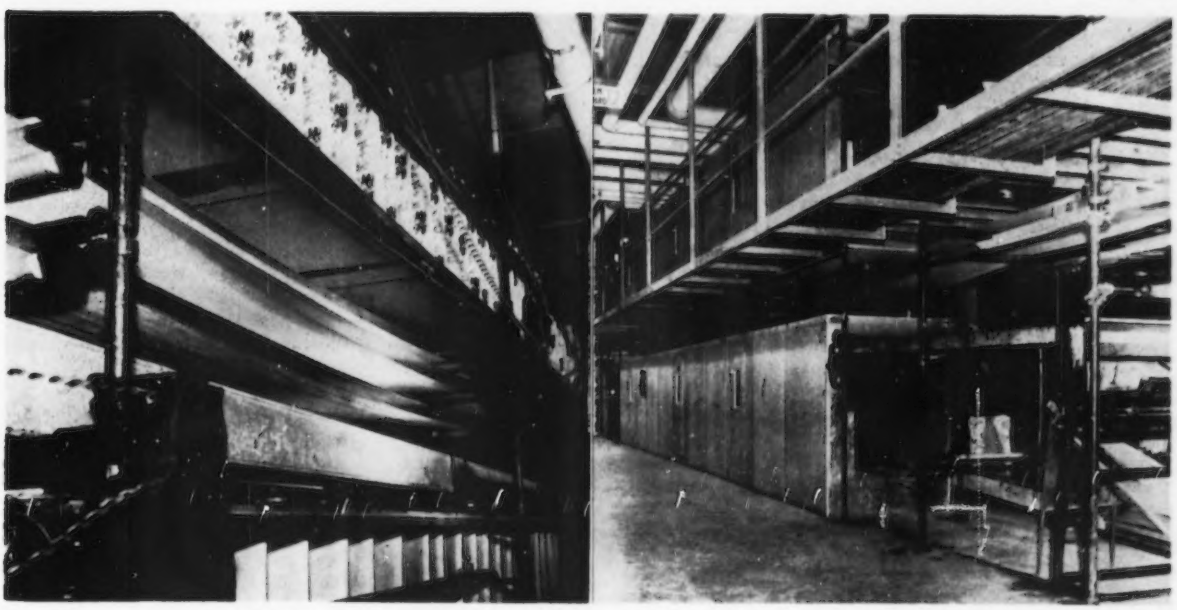
It is interesting to note that the United Montgomery plant, the most modern in the industry, is equipped to perform all of the above manufacturing operations in one continuous process, i.e. from raw stock to finished roll.

Raw Stock

The greatest tonnage of paper used in wallpaper manufacture is groundwood hanging. "Groundwood hanging" covers a type of paper very similar to news, that is specially formulated for wallpaper use. The general range of composition is 75 per cent to 80 per cent mechanical ground wood, the balance being sulphite.

Color and the uniformity of color are of utmost importance. Color variations in the raw stock will cause like variations in the finished product.

The bulk of ground wood hanging stock is made in a variety of weights



The above pictures show wall paper dryers. The right hand picture shows the drying racks on which the wallpaper is hung in festoons or loops carry the wallpaper through fanned and heated air. On the lower rack is shown the paper with only the ground coating applied, passing through the drying rack on its way to the printing machine. On the upper rack is shown the paper after the pattern has been applied.

View of finished wallpaper leaving festoon racks on way to rolling equipment.

View of the finishing end of a group of wallpaper machines, showing reeling machines and automatic rolling machines.

between 36½ lbs. and 66 lbs. per ream, depending on quality and finish of the the individual sheet. The ream size for this industry is 24x36-480. Ounce weight is the most commonly used terminology for basis weight. The method of conversion used is to multiply the ounce weight by four and add two, this equalling the ream weight. The exact reason and meaning for this rather unusual nomenclature is lost in antiquity, but it probably had its original starting point from the weight of a roll of wallpaper, of the length and width of the period when wallpaper was first manufactured by machine printing in England.

This might be a good place to point out the size of wallpaper. For the purposes of accounting, sales, orders, etc., a roll of finished wallpaper is the standard unit. This unit contains 36 sq. ft. of pattern. The bulk of goods are made on 19¼-inch raw stock. Large quantities of 22-inch and 30-inch stock are also used. For purposes of usage, no single rolls of wallpaper are made, the conventional unit of wallpaper being actually a double roll.

Weight is of considerable economic importance to the wallpaper converter. Shipments are checked with the standard ream weight balance and there are periodic checks during use for this factor. Even in the very smallest of mills, where there is only one piece of test apparatus, one will find a ream balance.

As compared to newsprint, ground wood hanging carries considerably more size. I believe that in the terms of paper manufacture, the usual sheet is somewhere between two and three per cent sizing. A variety of methods have been used for testing sizing, ranging all the way from the news penetration tester, Valley size tester and flotation tests of one kind or another.

We have found in our particular case that flotation on top of Sanford's Blue-Black Ink #1 is the most reliable test for our usage. The end point in this particular test is not the first pin hole penetrations of ink, nor is it when there is complete penetration with the blackening of the sheet. It has been found by practice that there is an intermediate spot which is quite reproducible. Using such a test and such an end point, we have been able to guide the paper manufacturer quite well, so that the complaint structure in our own operations, or as far as finished product is concerned, is held at a minimum. Numerically, we have put a two-minute minimum for this penetration and look with questioning eye at anything above six minutes.

Stock that is low in sizing tends to give us trouble from two angles; first, uneven coating, tending to be blotchy and poor in uniformity of surface reflectance. This is of special significance on some pastels and all deep colored coatings. Secondly, low sized stock will tend to eat up an excess of sizing from the coating composition and the product will be in danger either from low water resistance in the case of washable papers or, if carried to an extreme, will result in crocking of color on rubbing, a very objectionable characteristic even after the paper is on the wall.

The majority of stock is rosin sized, and probably most stocks today contain some wax with the rosin, as a means of getting a little more pliability into the sheet. Starch sizing has been used experimentally, but it has never been a major factor in the type of stock produced for our use.

Porosity of the sheet is of extreme importance, especially if the Densometer readings get too high. Sheets with high porosity tests in terms of Gurley time units (high density stock) tend to curl very badly on our festoon racks and with the comparatively low strength stock, the wastage factor will mount tremendously. Of course, this density maximum varies with the weight of stock, but with a 38 lb. stock for example, Densometer readings of over 25 seconds are a pretty good indication that one is heading for trouble. Low porosity ties in with low strengt and low sizing, affecting water resistance.

Most mills which produce ground wood hanging stock are specialty mills with a past history in the production of ground wood sheets, either news or periodical. There has been some shifting of mills in recent years from and to this type of paper. In the main, the production has centered in Michigan, Minnesota, upper New York State and Maine.

There are a number of specialty sheets used in the industry, such as the No. 1 white printing sheet used in engraved printing. Others are ground wood sheets, modified with addition of kraft pulps used for ready paste and plastic coated wallpapers.

Summarizing, the qualities of a good wallpaper hanging stock are:

1. Porosity and ink penetration are important controls. The balacing of these factors will result in a sheet which will ground well and will not curl in the drying ovens.
2. Resistance to tear and bursting are basic requirements for deep embossing without stock cutting and to maintain a low scrap factor in operations.
3. Finally, the finished sheet must hang easily. Edges must lie tight to the wall. Paper must have sufficient wet strength to sustain handling required in hanging. The sheet must wet and dry uniformly, otherwise blistering and wrinkling will result on the wall.

Baryta Coated Photographic Paper

William A. Kirkpatrick

Vice-President and Technical Director, Allied Paper Mills

In the year 1855 a Frenchman named Moitessier first showed photographs using as a base an enameled paper. This proved to be only a slight improvement over uncoated papers previously used and it was not until 1867 that Schnauz showed photographs on paper in which an intermediate film of barium sulphate or baryta was used between the fiber base and the silver emulsion. In 1881, a patent was issued to Hutinet and Lamy in Paris covering a process for coating photographic base stock with a gelatin solution containing barium sulphate. This patent was the basis for the production of glossy photographs, however, the impact of the development was far reaching in the photographic field because when photographic raw paper is coated with this combination of gelatin and barium sulfate, the emulsion of gelatin and silver salts is prevented from penetrating into the fiber base and the result is a sharp clear image, a great improvement over results obtained on an uncoated, raw photographic base.

The baryta coating of photographic base stock, as originally practiced, achieved outstanding results because it had a tendency to cover up mechanical, chemical, and photochemical defects in the base stock, however, advances in the manufacture of pure alpha pulps, made during the past few decades, and the surface treatment of raw paper in the tub on the paper machine has minimized the necessity for baryta coating merely to improve the purity of the base which will be emulsion coated with the silver halides.

Mr. Kirkpatrick is a native of Portland, Maine, and a graduate in chemical engineering from the Massachusetts Institute of Technology. After four years' experience with the S. D. Warren Co., Cumberland Mills, Maine, he joined the staff of Allied Paper Mills, Kalamazoo, Mich. in 1936 where, at present, he holds the position of vice-president and technical director.

Mr. Kirkpatrick is a past chairman of the Kalamazoo Valley Section of TAPPI and of the NON-Fibrous Materials Testing Committee of TAPPI. He is a member of the American Chemical Society and the Technical Assn. of the Graphic Arts. He is co-founder of the Curriculum of Paper Technology at the Western Michigan College in Kalamazoo and has been a member of the Advisory Committee as well as of several special committees on Paper Technology at that educational institution.

Baryta coating is used, however, on nearly all fine pictorial papers where delicate and sharp contrasts are desired and, of course, on all glossy printing papers.

Photographic purity is the outstandingly desirable characteristic of baryta coating. This purity normally exceeds so-called chemical purity by a marked degree and can be achieved only by most exacting manufacturing and technical procedures. In the main, a baryta coated photographic base stock consists of an alpha cellulose fiber base with extremely closely controlled purity and physical characteristics which in turn is given a single or multiple coat of a mixture comprised principally of pure precipitated barium sulphate and an exceptionally pure grade of gelatin specifically manufactured for the purpose.

The Base Stock

In view of the fact that this paper will deal principally with the baryta coating process, the manufacture of the special base stock will only be touched upon briefly. Suffice to say that it is comprised principally of alpha cellulose of special types and for most types of paper it is of wood origin, although in some of the lighter weights 25 to 50 per cent of pure rag pulp may be used for additional strength. The paper must be manufactured with high wet strength, tinted to the proper shade, and with surface characteristics in line with the end use requirements of the paper. The surface may vary all the way from an exceedingly smooth finish to one which is decidedly antique or, in some cases, even embossed. The embossing may be done on the base stock as a separate operation after the paper his been finished on the paper machine or, in some cases, it may be done while the

paper is still in a comparatively damp state on the paper machine itself. Most baryta paper used in the United States is 41 inches wide, although certain types are purchased in widths of 43 inches or 37 inches. The weight of the base stock is normally specified in grams per square meter. The weights normally encountered are 80, 105, 135, 200, and 250 gram. It has always been customary to designate the weight of the finished baryta coated sheet, regardless of the weight of the baryta coating itself, by the weight of the base stock used. In the United States today, there are only two recognized sources of base stock for baryta coating. These are the Eastman Kodak Company of Rochester, New York, which converts 100 per cent of its production, and the Lee Paper Company of Vicksburg, Michigan, all of whose production is converted by the Allied Paper Mills of Kalamazoo, Michigan. The two latter firms entered the photographic paper field in 1939 when it became apparent that European sources for photographic base papers could no longer be depended upon because of the imminence of World War II. Up until this time all photo sensitizers who did not buy their unsensitized base directly from the Eastman Kodak Company had to depend entirely on European manufacturers for their principal raw material and, of course, these sources were cut off completely with the exception of approximately 600,000 pounds per year from 1941 to 1948. This turned out to be a period of grace for the new mills in the field during which time the development of satisfactory products took place, to a certain extent under the pressure of national defense. The development somewhat parallels the domestic production of gelatin and dyestuffs during and shortly after World War I.

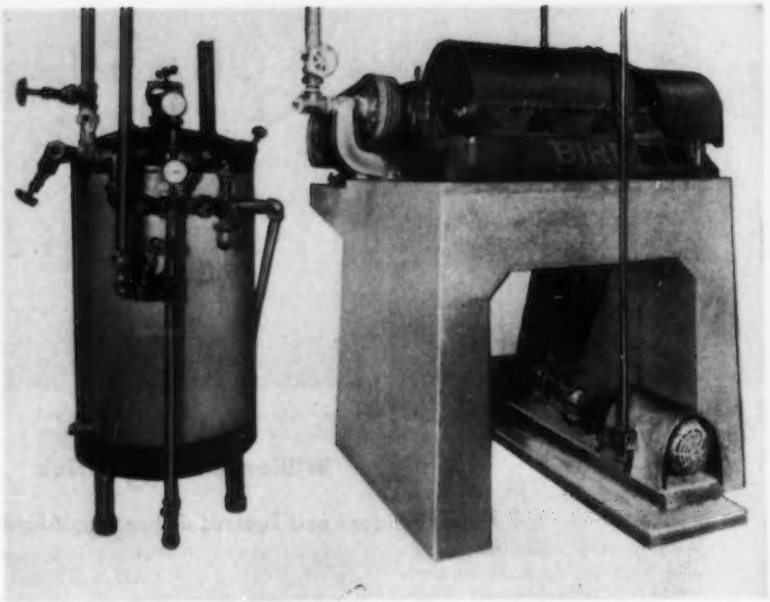


Figure 1—A section (left) showing part of the deionizing equipment used for water purification and (right) the Bird centrifugal filter used in the purification and washing of the baryta or barium sulfate.

Manufacture of Barium Sulphate

The formulation of baryta coatings is, on the face of it, comparatively simple, however, each ingredient in the coating must be carefully controlled for purity and physical characteristics. Barium sulphate pure enough for coating photographic base stock is not available commercially and must be made by the manufacturer. It may be produced by bringing together, under controlled conditions, solutions of barium chloride and sulphuric acid or barium chloride and sodium sulphate. Conditions of dilution, temperature, and degree of agitation must be carefully controlled in order that the particle size of the precipitated barium sulfate be in line with the requirements in the finished product. The precipitated barium sulphate must be washed thoroughly of the by-product, hydrochloric acid or sodium chloride as the case may be. Fortunately both of these by-products are extremely soluble and may be removed with comparative ease either by settling and decanting eight or ten times or preferably by the use of a continuous centrifuge. (Fig. 1) In the manufacture of barium sulphate, as in all phases of the production of baryta coated photo-

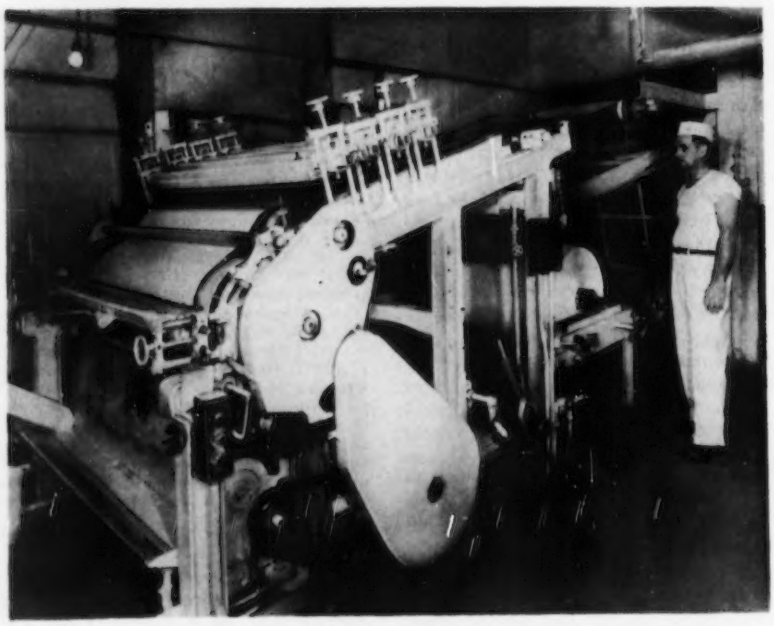


Figure 2—The coating machine showing (left) the jacketed coating pan for controlled temperature, (upper center) the oscillating brushes for spreading and smoothing the coating, and (upper right) the web of paper entering the drying section.

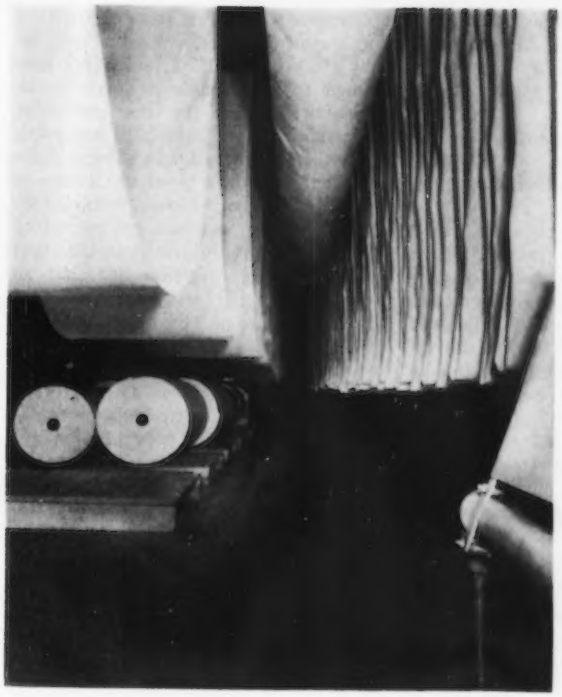


Figure 3 — Drying rack showing paper hanging in festoons and the special fabric, covering all moving parts to prevent contamination of the wet coating. (Lower left) shows rolls being stored at high temperature and humidity preparatory to being coated.

graphic base stock, any water used must be exceptionally pure, preferably deionized or distilled. It must be checked continuously for purity and stored under conditions which will not permit the growth of bacteria.

Historically, barium sulphate was made into a heavy cake in a filter press and stored in wooden barrels. It arrived at the coating plant containing about 30 per cent water. Today, however, the concentrate from the centrifuge is handled at a 40 to 50 per cent dry solids basis and is pumped from storage tanks to mixing equipment, thereby, eliminating the possibility of contamination by exposure.

Coating Formulation

The gelatin used in the production of baryta papers must be very carefully selected and is usually purchased from concerns who specialize in the production of photographic grades of gelatin. The grades used will vary somewhat with the results desired, but normally a second or third extraction from calf stock is acceptable. The bloom on this type of gelatin will run about 125 to 150 and the gelatin should be substantially reducible sulphur free. It may be tested by the standard TAPPI method and by this method, the lead acetate moistened paper should not be discolored perceptibly. This would mean the reducible sulphur content of the gelatin would probably be below two parts per million. In the production of the coating, the gelatin is first soaked in cold water in order that it may swell and it is then subsequently melted by the use of indirect steam. Here, as in all other phases of the baryta coating operation, the paper and coating must be handled only in equipment made of stainless steel, wood or other material which will insure the product not being contaminated with heavy metals or any oxidizing or reducing material.

After melting, the gelatin is added to the baryta slurry and the *ph* is adjusted with citric acid.

The formulation is completed by the addition of hardening agents which react with the gelatin such as chrome alum or formaldehyde and glycerine to keep the baryta film flexible. The recent wide variation in the price of glycerine has encouraged the use of sorbital as a substitute with excellent results. The coating mixture, as applied to the paper, must be free of foam and until comparatively recently, milk was used as an anti-foam agent, however, today normal butyl alcohol is almost exclusively used in this regard. If the coating has any tendency to be frothy, tiny pin holes in the surface will result which will not accept the sensitizing emulsion properly and which will prevent the finished print from being satisfactorily ferrotyped to a glossy finish.

The natural shade of the baryta gelatin mixture tends toward the cream white. Currently a blue white shade is considered the most desirable for most papers and in order to achieve this, certain tinting agents may be used. These tinting agents must, of course, be fast to light and also fast to acids and alkali. They must also be bright and comparatively pure in their color characteristics. There actually are very few tinting materials which will meet these specifications and still be photographically inert as far as the emulsion is concerned.

With regard to the hardening of the gelatin in the baryta film, it might be well to state that this must be very carefully controlled. If too much hardening agents are used, there is a tendency for the subsequently applied sensitive emulsion to lack proper adherence to the baryta coating and if not hard enough or waterproof enough, there is a tendency for the coating to slough off during subsequent processing of the exposed sensitive emulsion. The amount of gelatin used on the barium sulphate will depend to a certain extent on the requirements of the photo sensitizers. Various emulsion formulations vary in their demands upon the baryta film and what may prove entirely satisfactory for one photo sensitizer may be useless to another.

Coating Application

After the coating has been properly prepared, it is normally screened through a 200 mesh stainless steel vibrating screen and subsequently is passed through a silk or nylon mesh of special design. The temperature of the finished coating is carefully controlled and is then ready for application to the paper web. The application may be made on several different types of coating equipment, but the most commonly used are the single brush coater (Fig. 2) and the so-called air brush coater. When using the former for the production of glossy papers, normally two or three coatings are applied to the same side of the stock. Occasionally the paper is calendered between coatings and it is always calendered after the last coat. If a surface pattern is desired, the pattern is normally built into or placed upon the fiber base before coating. A single coating or carefully controlled weight will then give the desired pattern. Semi-matte or semi-dull coatings may be produced by variations in the calendering procedure, but full-matter coatings or extremely dull finishes must be obtained by the use of a matting material in the baryta coating such as special types of uncooked rice or corn starch.

Drying

The drying of baryta coated paper is a very exacting operation. As the

paper leaves the coating machine, it goes through a series of control zones (Fig. 3) in which both temperature and relative humidity are carefully adjusted to the particular stock being coated. The air used in the operation, indeed all of the air used throughout the entire plant, must be super clean and to achieve this, a very elaborate system is set up for purification in order to insure that no trace of contaminating dust is allowed to reach the plant in which the baryta coating is performed or the adjacent sections where the coating is prepared or the calendering and finishing done. The whole plant is normally kept under air pressure so that if the building be not air-tight, the leakage will be from within rather than from without. After the paper has passed through the drying cycles, it is rewound into jumbo rolls with a moisture content running between 8 and 10 per cent. It is then ready for the calendering operation.

Calendering and Finishing

With the exception of taking extraordinary precautions from the standpoint of contamination, the calendering of baryta coated paper is similar to what is normal practice on ordinary book papers, (Fig. 4) although because of the high purity of the materials, it is possible to calender under much higher pressure without detracting from the appearance of the finished surface. The barium sulphate pigment does not show the same tendency to "blacken" that china clay does in the production of even the highest grades of printing papers.

Baryta coated paper is subject to inspection in nearly all phases of its production. The production takes place in rooms which are painted pure white with special paint and which are extremely well lighted. Defects noted at any time during the process are immediately removed and not allowed to go along to the final inspection point. The final inspection point in most cases is the rewinder (Fig. 5 & 6) which takes the jumbo rolls from the calender and trims off both edges, subsequently forming up a roll normally 17¾ inches in diameter. During the rewinding operation, the paper is passed at a comparatively slow speed over a very bright light allowing the operator to inspect the sheet by transmitted light which will in most cases show up defects which might be expected to cause trouble in any subsequent operation. The paper is wound on specially constructed solid wooden cores which project about two inches from each end of the roll. The roll is suspended by the core in a specially constructed crate after having been wrapped and sealed in a waterproof and dustproof wrapping.

Testing

One of the most important and costly operations in connection with the production of baryta coated photographic base paper is the testing necessary to insure the delivery of a satisfactory product. Many of the normal paper tests customarily used on other papers are used on baryta coated photographic paper. However, the most important single test which can be applied during the various phases of the production is the test for iron and heavy metals. This is done by merely dipping the test strips into a solution of acidified potassium ferro-cyanide. Iron spots by this test turn a bright blue whereas a copper or bronze spot shows a brown-red coloring. This test is useful only as a control test, however, and the real test involves emulsion coating.

Samples are drawn from each of the finished rolls. The emulsion selected may be either of a standard type known to be suitable or may be an emulsion supplied by the particular customer involved who may not wish to divulge his actual formulation. It is a fact that certain types of defects in baryta coated paper may become evident only after a prolonged period of storage. It is, therefore, important that in making the emulsion test that an accelerated aging test be carried out at the same time. By this method it can be determined within a period of a week or ten days approximately how the paper will behave after storage over a period up to twelve months. In testing baryta coated paper, a standard or type is always sensitized along with production samples as a means of reference and this type and the test samples are put through all the normal photographic procedures involving exposure, developing, and fixing. Flash

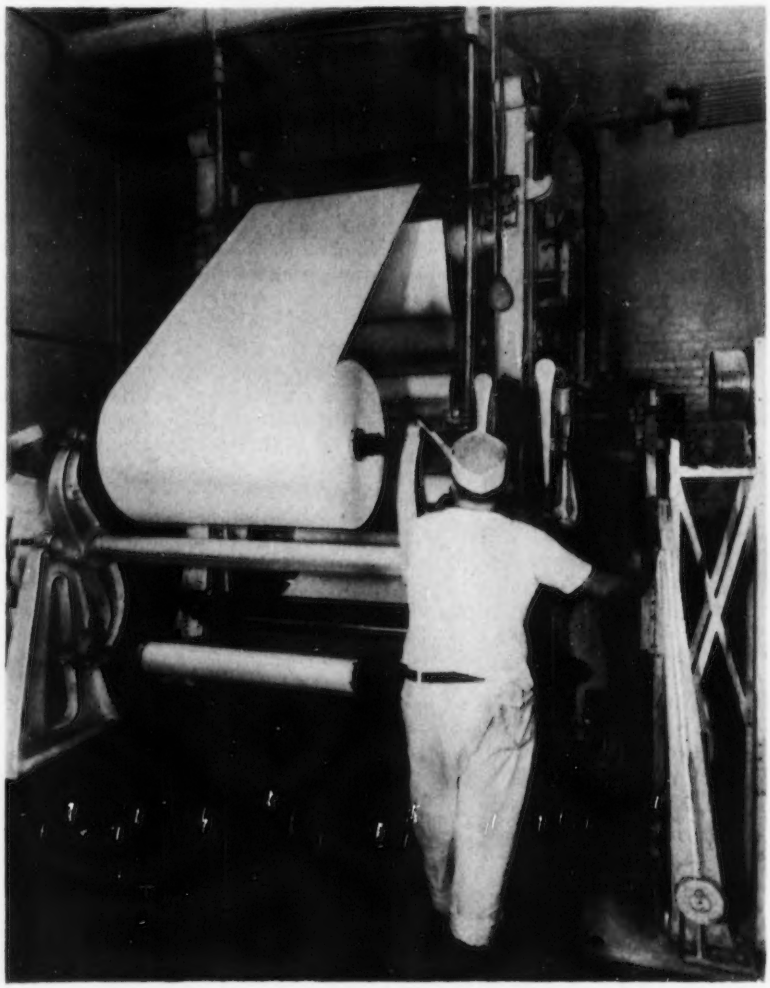
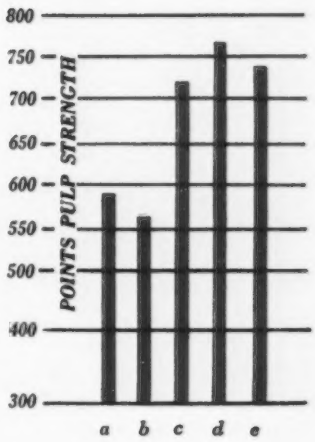
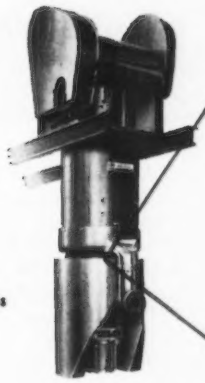


Figure 4—The calendering operation as used on glossy papers.

What happens to SCREEN REJECTS in your mill ?

PULP CONTAINING 5% REFINED REJECTS SHOWS 7½% MORE STRENGTH THAN NORMAL HIGH YIELD KRAFT—WITH HIGH QUALITY APPEARANCE RETAINED





medium size
J-C Zenith Press

a. 100% rejects — one pass in high density refiner

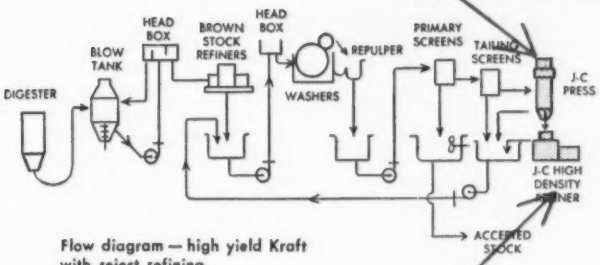
b. 100% rejects — two passes in high density refiner

c. Normal high yield Kraft pulp

d. 95% C & 5% A

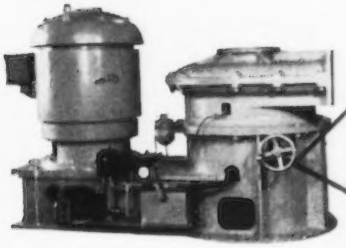
e. 95% C & 5% B

Points pulp strength = 2 × Mullen plus tear. (Note that pulp containing refined rejects is stronger than normal pulp and equal in appearance.)



Flow diagram — high yield Kraft with reject refining

RECENT TESTS PROVE A SUPERIOR PULP RESULTS FROM MIXING A PULP NOW LOST (REJECTS) WITH NORMAL HIGH YIELD KRAFT



J-C 015 Refiner

You can have similar savings with the simple installation of a J-C PULP PRESS and 015 HIGH DENSITY REFINER in your present system. Here's how the J-C system makes possible these remarkable savings . . .

After leaving the tailing screens the rejects are pressed to high consistency, processed in the specially designed 015 refiner and returned to the blow tank. A wide separation between the plates allows the 015 refiner to operate at high density with less power per ton of pulp. A striking feature of the 015 refiner is its inherent ability to produce long fibers, resulting in better tear.

THESE PLUS FEATURES OF THE J-C PRESS AND REFINER SYSTEM ADD UP TO EXTRA SAVINGS:

- By eliminating rejects, digester capacity is improved; cost of chemicals per ton is reduced.
- Reduces amount of dilution in black liquor.
- Output of mill is increased by amount of rejects (5%).

Our engineers and facilities are at your service. For information, write Dept. P.

J-C **JACKSON & CHURCH CO.** SAGINAW, MICHIGAN

Work well done since eighty-one

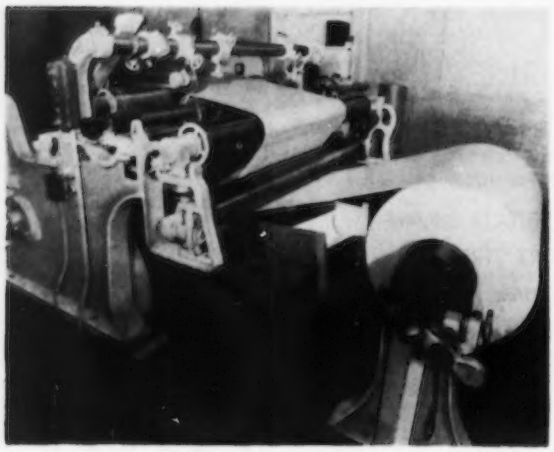


Figure 5—The unwind stand at the rewinder showing facilities for inspecting the paper by transmitted light and also showing the trim on the edges being removed and disposed of through an opening in the florr.

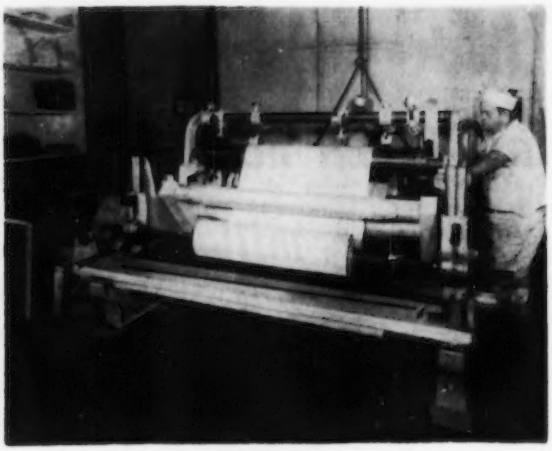


Figure 6—The front side of the rewind stand showing the finished paper being spooled for shipment after having been inspected, trimmed, and the surface vacuum cleaned by the apparatus in the center of the picture. It will be noted that the wooden core projects slightly beyond the end of the paper in order that the finished roll may be suspended by this core in the shipping crate.

tests are made on strips running the full width of the roll and these are examined with great care for the occurrence of spots of highly reduced silver or insensitive areas; either might be cause for rejection. Before the processed paper is dried, the surface is scratched to see whether the sensitive emulsion is satisfactorily adhering to the baryta surface. If it is not, it is said to frill. This is a serious condition and if encountered, it would be cause for a rejection of the paper for use with the particular emulsion under consideration. There might, however, be other emulsions which would work perfectly satisfactorily on it. Control strips, again using a standard sample as a reference, are made to show speed and gradation with a given emulsion. The sensitized paper is also checked under various types of safelights for sensitivity. The sensitivity is influenced by various trace materials and dyes which may be in the coating formulation.

Of recent months, an interesting and rather disturbing development has taken place in the production of photographic paper, both uncoated and coated. As a result of atomic explosions in Nevada, clouds of radio-active dust have drifted over the Northeastern section of the country. A rain storm will often cause this dust to contaminate water supplies and air. While the radio-activity is not high enough to be of any particular concern to us in our normal everyday life, it is extremely serious in the production of photographic paper. When the first explosion took place, a tremendous amount of paper was ruined because the producers were not familiar with the effects. Now, however, special precautions are taken and all production is checked with a geiger counter continuously and if the count goes above a certain predetermined low limit, the paper being produced is set aside and production stopped until the situation has cleared up. The paper is also checked by placing it in contact with x-ray film, which is extremely sensitive to emanations from the radio-active particles. The type of air cleaning equipment in normal use in baryta coating plants is adequate to remove radio-active dust and, if water is obtained from wells, it is usually free from contamination. Surface waters, however, are readily contaminated.

Very accurate records must be kept both as to the manufacturing operation on each individual roll of paper and also on the results of the extensive tests to which the finished product is subjected. Shipments are normally not made until the paper has been thoroughly tested and approved as being in line with previously established standards.

Production

In the over-all economic picture, baryta coated photographic papers probably represent the smallest item in terms of tonnage that will be discussed at this Western Michigan college course. In 1952 there was imported into this country 90,000 pounds from Belgium, 700,000 pounds from Germany, and 1,700,000 pounds from the United Kingdom. The total imports were approximately 2½ million pounds, although prior to 1950 the imports were over a million pounds only in the years of 1937 and 1938. The price of baryta coated paper may be of some interest. Currently this runs between 35 and 45c per pound, although some of the imported stocks will run perhaps 8 to 10 per cent below this. No figures are available on the tonnage of baryta coated paper produced in this country, but it is suffice to say that, excepting the largest individual consumer of photographic paper, the demands of all the others could probably be met by the production of two or possibly three modern coating machines, run at moderately high speeds.

An interesting sidelight on the production of baryta coated photographic paper is that in the late 30's twelve individual coating mills attemped to produce this interesting technical specialty but without success. The principal reason for failure seems to have been the unrecognized necessity for absolute cleanliness and purity in its production, although another contributing factor may have been the unavailability of a suitable base stock for the baryta coating. It is really unfortunate that the demand for baryta coated papers is not great enough to justify its production by more mills. It is a vital military necessity and one which attracted considerable attention from our bombers in their forays over Europe in World War II. We were in the untenable position as we entered World War II of having only one producer in the Western hemisphere. We now have two, but it can be readily seen that the tonnage requirements are not such as to justify a third, at least for the present.

Actual installation of new Puseyjones Watermarking Attachment on upper press roll.

Modernize with New Puseyjones Watermarking Attachment

If you are using cumbersome, spring-loaded watermarking units, here is important news for you. Puseyjones has developed a new Watermarking Attachment with controlled air-loading for each marking unit. Mill-tested, mill-proved for superior, uniform watermarkings across the sheet. Installed in the press section, either directly on the upper press roll or on the run of the sheet between the presses.

In this new attachment, the drums are made with demountable rims, having marking bands molded thereto. Rubber marking bands easily replaced when changing watermarks. Present marking bands may also be used with this attachment. Write today or call our District Representative near you.

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Established 1848. Builders of Paper-Making Machinery
Fabricators and Welders of all classes of Steel and Alloy Products
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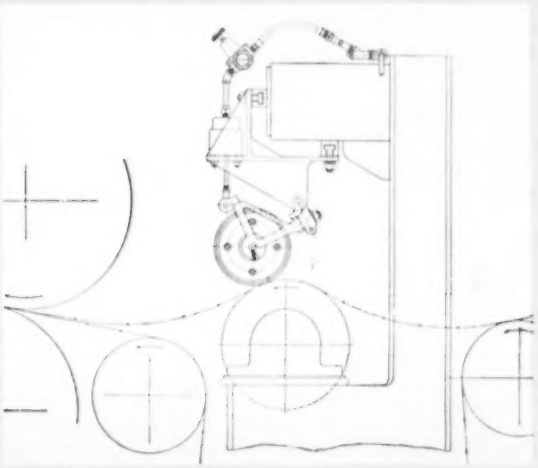
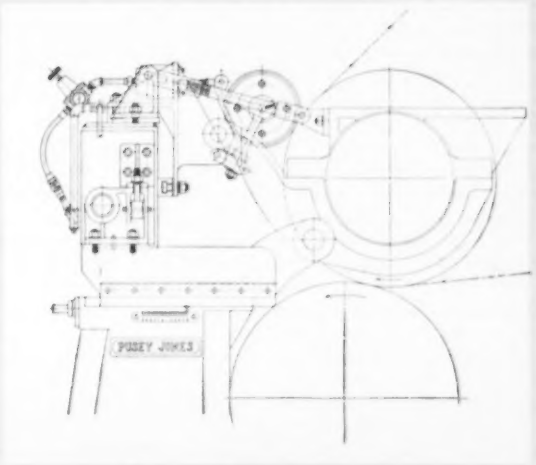
Typical installation between the presses.



Typical installation on upper press roll.



Paper Base Laminates

James E. Kussmann

St. Regis Paper Co., Panelyte Division

In discussing laminating we will not discuss the gluing together of sheets of paper by means of applying an adhesive to the surface and thus forming a sheet of material of many layers, but we will discuss a laminate formed by the pressing together into a homogeneous mass sheets of paper which have been saturated, or impregnated with a resin binder. We will also limit our discussion to high pressure laminating, that is material which is pressed at pressures exceeding 1000 lbs. per sq. inch.

It is generally conceded that the development of the laminating industry received its impetus from the electrical industry. The need for insulating boards in this field led to the development of the pressing together of sheets of paper, which had previously been coated with solution of natural resin, such as shellac. These early developments were satisfactory for some applications. However, there was a real need for a material that would not soften at relatively high temperatures. In 1912 Backeland through his work of reacting phenol and formaldehyde together was granted a patent which referred to laminating sheets of paper together with a phenol-formaldehyde resin. Since that time the process of impregnating and pressing paper into laminated boards has resulted in a multitude of grades for specialized uses. In addition to flat sheets, the industry turns out rolled and pressed tubes and rods and has developed the pressing of paper based laminates into molded items. Today the laminating industry is the most important user of paper in the plastic industry.

As a result of specialized requirements of users of laminated material, the laminator and the paper manufacturer have worked in close collaboration in developing materials to fill the needs of many industries.

James E. Kussmann attended Principia College, Elsah. Ill., majoring in economics. After college became associated with a consulting engineering firm Barnes Textile Associates at Boston, Mass. Spent four years working as an engineer in textile mills throughout the East.

Enlisted in the Navy August 1941. Obtained Navy Wings in May of 1942. Had overseas duty in the Pacific flying carrier based aircraft. Was released from the Navy in September 1945, and joined St. Regis Paper Co., Panelyte Division in October 1945 at the Trenton, N. J., plant.

Assumed position of plant manager for the Kalamazoo plant of the Panelyte Division in August 1949.

There are many types of paper used in making laminates. In addition to paper, other material such as pulp board; asbestos paper; asbestos cloth; fine, medium and coarse weave cotton cloth; staple fibre and continuous filament glass cloth; glass mat; nylon cloth; and others are also used. You will note below a table of the grades manufactured by the Panelyte Division of St. Regis Paper Co. From this you will see how many different types of material are manufactured. This list by no means covers all of the grades manufactured. If a customer desires some grade with properties which he feels are not present in existing grades, he will work closely with the plastic manufacturer, who will attempt to give him the properties that he feels he desires.

The laminating industry developed first from the flat sheet. The next step was the rolled tube, then came the molded laminated piece. All of these products have some of the same fundamental manufacturing steps and only differ in the final form they take. In other words, it is the pressing operation, or in the case of the tube, the rolling operation, which determines the end product. The paper and the resin must be united prior to the pressing operation.

Resin

One of the two essential ingredients in making a laminated sheet is the resin. The resin is used as a binder for the paper fibers. It also forms a continuous surface film, which gives the laminate some of its properties. The type of resin and the degree it penetrates the fibers affects the compressive strength, the impact strength, the water absorbtion, the resistance to chemicals, and the sheer strength in the direction of the laminate. There are many types of resin used for laminating, but the most widely used is the phenolics in many forms. It might be added that these are also the cheapest.

Thermosetting phenol-formaldehyde resins are manufactured in approximately this manner. The phenol and formaldehyde, the modifying agents and the catalyst are charged into a kettle where they are refluxed under carefully controlled conditions. The length of time of reaction determines the properties of the resins and also the conditions of impregnating and pressing. When the reflux is complete, water is removed by distillation under vacuum. Then a solvent, usually alcohol, is added to the resin, which keeps it in a liquid state by checking reaction of the resin. This liquid resin is referred to as an impregnating varnish. The resin has gone through one stage in the manufacture of the laminate.

Treating

The next step in the manufacture of a laminated board is the impregnating of the paper with the varnish. (In addition to the term impregnating, the terms saturating, coating, and treating are also commonly used.) In this op-

eration the resin is applied to the paper. There are many methods in which this is accomplished. One method, which is pictured below, is that of the dip squeeze roll impregnating method. The paper is placed on a back stand and the web fed into a dip tank filled with the liquid resin. The specific gravity of the varnish helps control the amount of varnish the paper will retain in treating, but in addition a set of closely machined hardened squeeze rollers through which the paper travels after it leaves the dip tank help meter the amount of varnish re-

Characteristics and Properties

Grade 750(X)—A strong phenolic paper-base material with best mechanical properties and high dielectric strength when dry, but should be used with discretion when high humidity conditions are encountered.

Grade 550(XX)—A general purpose phenolic paper-base material, suitable for electrical applications and having good machinability.

Grade 520(XXX)—A phenolic paper-base material for electrical applications; excellent moisture resistance and low cold flow.

Grade 770(P)—A phenolic paper-base material for punching applications, can be punched cold in thinner thicknesses; for general purpose electrical applications where a high degree of insulation is not required.

Grade 772(PC) — A phenolic paper-base material for cold punching of intricate shapes up to ⅛ inch inclusive; for applications where electrical properties are secondary.

Grade 774(XXP) — A phenolic paper-base material for hot punching; good electrical properties and low moisture absorption.

Grade 776(XXXP) — A phenolic paper-base material for hot punching of high frequency electrical applications; very low moisture absorption and low power factor.

Grade 900(C)—A phenolic coarse weave cloth laminate having high impact strength and suitable for mechanical applications such as gears. Available as graphited grade 900G.

Grade 910(CE)—A phenolic coarse weave cloth laminate for applications requiring good mechanical strength and fair electrical properties.

Grade 940(L)—A phenolic fine weave cloth laminate of good impact strength, excellent machinability; for mechanical applications such as fine gears. Available as graphited grade 940G.

Grade 950(LE) — A phenolic fine weave cloth laminate of fair mechanical strength and good electrical properties; excellent machinability.

Grade 580(A)—A phenolic asbestos-paper laminate, slightly more resistant to heat and more resistant to flame than cellulosic paper grades; good moisture resistance; for low voltage applications.

Grade 980(AA)—A phenolic asbestos cloth laminate, similar in properties to Grade 580 but better mechanically, especially in impact strength.

LEGEND—(Figures in Light Face)

Grades decrease qualitatively from 1 to 10. (The lower the rating figure, the better that particular grade in that particular property.)

Panelyte Grade	750	550	520	770	772	774	776	900	910	940	950	580	980
Nema Grade	X	XX	XXX	P (XP)	PC	XXP	XXXP	C	CE	L	LE	A	AA
Government Grade	JAN-P-13 Type LTS-M-1 (PBM)	MIL-P-3115A PBG	MIL-P-3115A PBE	JAN-P-13 Type LTS-E-1 (PBP)		JAN-P-13 Type LTS-E3	JAN-P-13 Type LTS-E5	MIL-P-15035A PBM	MIL-P-15035A PBG	MIL-P-15035A FBI	MIL-P-15035A FBE	JAN-P-13 Type LTS-H-1 (PBH)	JAN-P-13 Type LTS-MH-1 (PBH)
Tensile Strength, Flat, lbs./sq. in.	14,000 5	9,000 8	7,000 10	8,500 9	8,000 9	8,000 9	7,000 10	9,500 8	8,000 9	9,000 8	8,500 9	8,000 9	10,000 7
Flexural Strength, Flat, lbs./sq. in.	23,000 5	16,000 8	15,000 9	15,500 9	15,000 9	16,000 8	15,000 9	20,000 6	17,000 8	20,000 6	19,000 7	16,000 8	20,000 6
Compressive Strength, Flat, lbs./sq. in.	35,000 7	34,000 7	32,000 8	22,000 10	22,000 10	25,000 9	25,000 9	38,000 5	36,000 6	35,000 7	37,000 5	36,000 6	38,000 5
Bonding Strength, lbs.	975 8	1,250 6	1,400 5	——	——	——	——	1,850 2	2,050 1	1,800 2	1,750 3	1,050 7	1,600 4
Impact Strength (IZOD) Flat, with Grain ft. lbs./in. width	2.20 7	1.05 10	0.90 10	1.55 8	1.7 8	1.25 9	1.15 9	3.6 3	2.6 5	2.8 5	2.5 6	2.0 7	3.9 3
Impact (IZOD) Edge, across Grain	0.60 8	0.45 9	0.40 10	0.60 8	0.55 9	0.45 9	0.35 10	2.2 4	1.5 5	1.4 6	1.2 6	0.9 7	3.3 3
Rockwell Hardness M Scale	110	105	107	95	85	96	100	90	107	105	105	111	102
Density Grams per cu. cm.	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.65	1.65
Water Absorption, Percent 24 hrs. for ⅛ in. thickness	2.30 9	0.95 4	0.70 3	1.90 8	2.0 9	0.95 4	0.70 3	2.5 9	1.7 8	1.4 7	0.9 4	0.85 4	0.85 4
Insulation Resistance, A.S.T.M. megohms for ⅛ in. thickness	25 9	200 6	250 5	100 7	25 9	200 6	300 5	——	25 9	——	100 7	——	——
Dielectric Strength, Volts/mil. for ⅛ in. thickness	500 3	500 3	470 4	500 3	500 3	500 3	470 4	150 8	360 5	150 8	360 5	160 8	50 10
Power Factor, 10^6 cycles/sec.	.060 9	.040 6	.032 4	.060 9	.060 9	.040 6	.027 3	.10 10	.055 8	.10 10	.045 7	——	——
Dielectric Constant, 10^6 cycles/sec.	6.0 7	5.0 4	4.8 3	6.0 7	6.0 7	5.0 4	4.5 2	7.0 9	5.5 5	7.0 9	5.0 4	——	——
Loss Factor, 10^6 cycles/sec.	.36 8	.20 3	.15 2	.36 8	.36 8	.20 3	.12 1	.70 10	.30 7	.70 10	.22 4	——	——
Sheet Size① Color②	1, 2, 3 N, B, C	1, 2, 3 N, B	1, 2, 3 N, B	2, 3 N, B, C	2, 3 N, B, C	2, 3 N, B, C	2, 3 N	1, 2, 3 N, B	1, 2, 3 N, B	1, 2 N, B	1, 2 N, B	1, 2 N, B	1, 2 N, B
Thickness Range	.010"–2"	.010"–2"	.015"–2"	.010"–.250"	.010"–.250"	.015"–.250"	.015"–.250"	1/16"–10"	1/16"–3"	.008"–2"	.008"–2"	.025"–2"	1/16"–2"

All tests were made in accordance with the latest A.S.T.M. test specifications.

Grade 120 — Staple fiber glass, phenol resin laminate for applications requiring Class B insulation of high heat resistance. Used for electric motor slot wedges and similar applications.

Grade 130 — A continuous filament glass — silicone resin laminate. Best dielectric loss. Especially formulated for high temperature applications (180°C.).

Grade 140 — Continuous filament glass base melamine resin laminate, possessing excellent arc resistance, heat resistance, and impact strength. High mechanical properties will not support combustion. Recommended for panel board and similar applications.

Grade 170 — Continuous filament phenolic glass cloth laminate of highest tensile, flexural, impact strengths, lowest water absorption, low power factor.

Grade 460 — Fine weave fabric-base, melamine resin laminate for mechanical applications requiring high strength; excellent machinability; arc resistance comparable to Grades 470 and 480.

Grade 470 — Fabric-base, melamine resin laminate developed to utilize excellent arc resistance characteristics of melamine resin in an electrical grade. Superior to Grade 480 in shock resistance and toughness but lower in electrical properties.

Grade 480 — A paper-base, melamine resin laminate developed to utilize the excellent arc resistance characteristics of the melamine resin in an electrical grade. High-frequency losses, dielectric strength, and moisture resistance are good.

Grade 490 — A melamine resin—carded asbestos laminate engineered for superior arc resistance under high operating temperatures in the range of 325°F.

Grade 506 — A phenolic paper-base laminate for hot forming and hot bending applications. This grade differs from 906, the canvas base grade, in that it cannot be formed to a zero radius angle, and requires a radius of at least one inch, and more care in post forming. It also differs from 906 in having higher tensile and flexural strengths and lower impact strengths.

Grade 906 — A heavy fabric-base, phenol type resin laminate developed for hot forming and bending applications. Superior to Grade 506 in forming compound curves and small radius bends. Available with non-afterglo and non-glare properties.

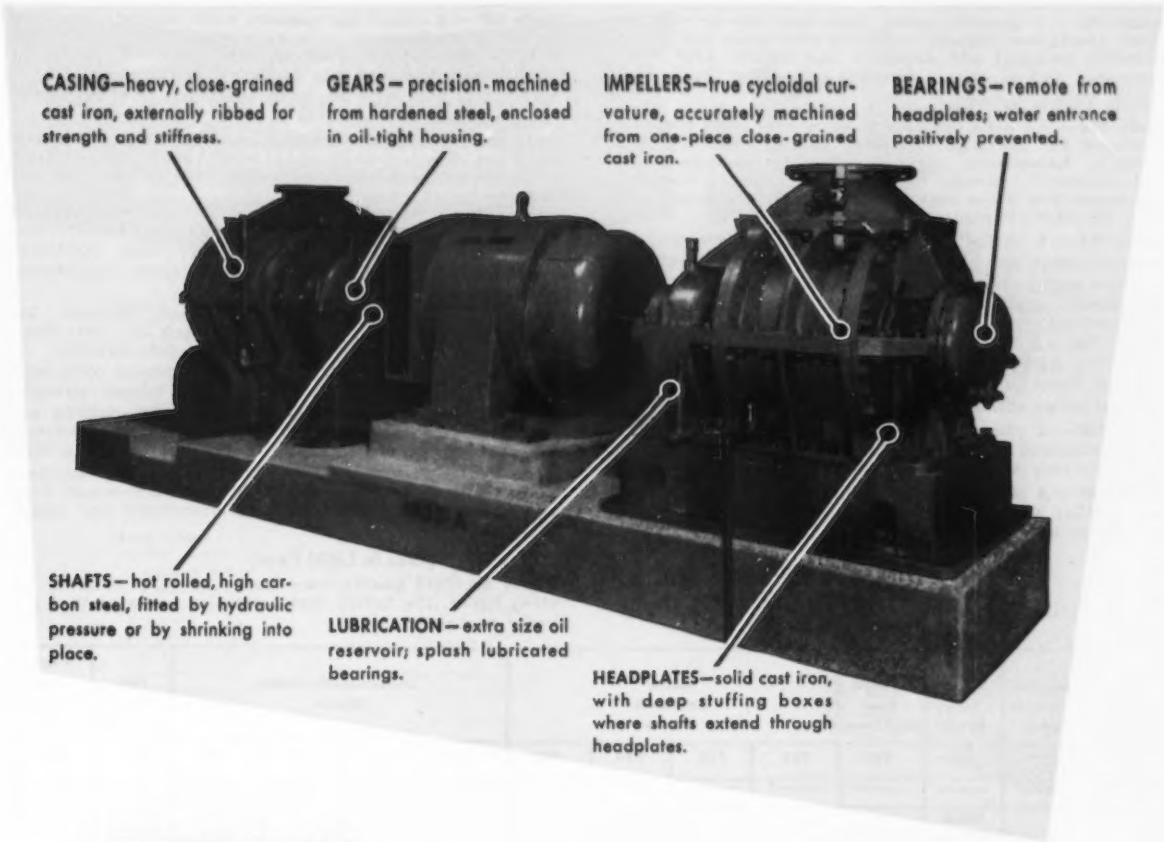
Grade 554 — A phenolic paper-base laminate, highest dielectric strength parallel to laminations, suitable for transformer and other high voltage applications. Other properties similar to Grade 550.

Grade 914 — A phenolic resin fabric base laminate possessing superior chemically resistant properties. Exhibits high strength retention after exposure to the most frequently encountered corrosive media.

	High Strength (Glass Base) Grades				Arc Resistant (Melamine Resin) Grades				Post Forming Grades	
Panelyte Grade	120	130	140	170	460	470	480	490	506	906
Nema Grade	G1, G2	G7	G5	G3	—	—	—	—	—	—
Government Grade		MIL-P 997A	MIL-P 15037A GMG							AMS 3605A
Tensile Strength, Flat, lbs./sq. in.	16,000 4	31,500 2	26,000 3	52,000 1	8,500 9	9,000 8	13,000 5	22,000 3	13,000 5	9,000 8
Flexural Strength, Flat, lbs./sq. in.	23,000 5	21,000 6	48,000 2	69,000 1	19,000 7	20,000 6	21,500 6	31,000 3	20,000 6	18,000 7
Compressive Strength, Flat, lbs./sq. in.	40,000 4	18,000 10	52,000 3	65,000 1	38,000 5	38,000 5	39,000 4	—	35,000 7	37,000 5
Bonding Strength, lbs.	1,300 5	850 9	1,700 3	1,800 2	1,800 2	1,750 3	750 10	—	900 9	1,850 2
Impact Strength (IZOD) Flat, with grain, ft. lbs./in. width	14.1 1	6.5 2	14.5 1	14.8 1	1.8 8	3.2 4	1.2 9	2.0 7	1.5 8	3.5 3
Impact Strength (IZOD) Edge, with grain, ft. lbs./in. width	10.3 1	6.5 2	11.0 1	12.0 1	0.9 7	1.6 5	0.35 10	1.30 6	0.5 9	2.1 4
Rockwell Hardness, M Scale	108	108	120	117	110	112	115	108	100	95
Density, grams/cubic cm.	1.60	1.80	1.87	1.82	1.45	1.45	1.45	1.70	1.35	1.35
Water Absorption, 24 hours 1/8" thick, per cent	1.8 8	0.30 2	1.5 7	0.1 1	1.3 6	1.5 7	1.0 5	2.5 9	3.3 10	1.9 8
Insulation Resistance, A.S.T.M. megohms	—	—	10 9	20,000 2	15 9	10 9	50 8	—	—	—
Dielectric Strength, 1/8" thick, volts/mil.	200 7	36 10	260 6	500 3	310 6	290 6	400 4	100 9	—	—
Power Factor, 10^6 cycles/sec.	.03 4	.015 2	.015 2	.006 1	.048 8	.065 9	.035 5	—	—	—
Dielectric Constant, 10^6 cycles/sec.	5.4 5	4.2 2	7.2 10	4.5 2	7.0 9	7.2 10	6.4 8	—	—	—
Loss Factor, 10^6 cycles/sec.	.16 2	0.100 1	.19 3	.27 6	.34 8	.47 9	.22 4	—	—	—
Arc Resistance, seconds	10 6	180 2	185 1	20 5	125 3	125 3	125 3	100 4	—	—
Sheet Size ① Color ②	1, 2 N	1 N	1, 2, 3 N	1, 2, 3 N	1, 2, 3 N	1, 2, 3 N	1, 2, 3 N	1, 2, 3 N	1, 2 N, B	1, 2, 3 N, B
Thickness Range	1/32"–2"	1/32"–2"	.010"–2"	1/64"–2"	.010"–2"	1/64"–2"	1/32"–2"	.047"–2"	1/32"–1/4"	1/32"–1/2"

† These tensile and flexural data are for with grain only, across grain figures are approximately one-half.

* These tensile and flexural data for with grain only. Across grain figures are approximately one-third of the with grain figures.


CASING—heavy, close-grained cast iron, externally ribbed for strength and stiffness.
GEARS—precision-machined from hardened steel, enclosed in oil-tight housing.
IMPELLERS—true cycloidal curvature, accurately machined from one-piece close-grained cast iron.
BEARINGS—remote from headplates; water entrance positively prevented.
SHAFTS—hot rolled, high carbon steel, fitted by hydraulic pressure or by shrinking into place.
LUBRICATION—extra size oil reservoir; splash lubricated bearings.
HEADPLATES—solid cast iron, with deep stuffing boxes where shafts extend through headplates.

REDUCE your operating costs with . . .

Successful experience of users proves the operating economies of the improved design of Roots-Connersville Vacuum Pumps for paper mills. Whether needs call for single-stage or compound units, these important advantages result:

1. **Lower operating cost** because of reduced power consumption; little sealing water needed; low maintenance cost.

2. **Reduced first cost** because of higher speed operation (600 rpm or more), requiring less costly motors, less expensive foundations and less floor space, because of increased capacity in one pump combination.

3. **Increased reliability** because of improved design and strict adherence to specifications, and selection of materials best fitted to specific needs.

For present or future requirements, you will be interested in details of R-C Vacuum Pumps, given in Bulletin 50-B-13, which will be sent on request.

R-C VACUUM PUMPS

ROOTS-CONNERSVILLE

Exclusive Specialists in Handling Gas and Air

ROOTS-CONNERSVILLE BLOWER A DIVISION OF DRESSER INDUSTRIES, INC. 1153 River Ave. · Connersville, Ind.

Reg. T. M.

Grade 190 — A phenolic nylon cloth laminate of very low water absorption, highest insulation resistance and lowest dielectric constant and dielectric loss factor. Low water absorption and excellent electrical properties. This grade retards fungus growth.

Grade 590 — An asbestos paper-base, phenol resin laminate, developed for mechanical application requiring high strength. Exceptional physical properties combined with heat resistance. Greatly exceeds other asbestos materials and approaches glass base materials in strength and stiffness. Excellent dimentional stability.

Grade 764 — A phenolic paper base laminate developed for terminal strips and other punched parts where strength is of prime importance Hhighest strength paper base available, electrical properties similar to Grade 770, suitable for hot punching.

Grade 766 — A phenolic paper-base laminate similar to Grade 770, NEMA XP, but much superior in insulation resistance. Good hot punching characteristics and suitable for terminal strips and applications requiring riveting.

Grade 780 — A phenolic paper-base laminate, hot punching, for applications requiring excellent electrical properties, especially very high insulation resistance.

Grade 782 — A phenolic paper-base laminate, for hot punching. Similar to 780 but with higher insulation resistance and higher heat resistance.

Grade 422 — A cotton mat phenolic resin laminate developed for textile applicatcns such as bobbin heads and for mechanical applications such as fine gears. Exceptionally smooth machined fuzz free edges are readily obtainable in combination with high impact strength and excellent dimensional stability.

Grade 922 — A phenolic medium weave fabric base laminate possessing excellent dimensional stability and machinability. Similar to Grade 942 with somewhat heavier fabric as base material.

Grade 942 — A light fabric-base, phenol resin laminate into which outstanding dimensional stability and machinability have been engineered. For use where close machining tolerances must be held and dimensions closely maintained for indefinite periods.

Grade 9101 — A canvas-base, phenol resin laminate. Developed for underwater service, particularly for valve discs. High resistance to water absorption and deterioration.

Grade 920 — A medium weave fabric-base phenol resin laminate; good machining properties. Good impact strength. Moderately low moisture absorption. For machining and mechanical applications where toughness and low moisture absorption are required. Available as graphited grade 920G.

Grade 260M — A phenolic paper-base laminate for mechanical applications such as fabricating jigs, fixtures and forming dies. Excellent strength, wear resistance and dimentional stability.

LEGEND—(Figures in Light Face)

Grades decrease qualitatively from 1 to 10. (The lower the rating figure, the better that particular grade in that particular property.)

High Dielectric Strength	Chemical Resistance Grade	Nylon Base Grade	High Strength Heat Resistance	Special Hot-Punch Grades				Dimensionally Stable Grades				Fine Weave Canvas	Paper Base Mechanical
554	914	190	590	764	766	780	782	422	922	942	9101	920	260M
		MIL-P 15047A NPG				MIL-P 3115A PBE-P					Navy Spec. 3384 Type A	MIL-P 15035A FBM	
10,000 7	7,500 10	12,000 6	30,000† 2	22,000 3	13,000 5	11,000 6	14,000 5	16,000 4	11,000 6	9,500 8	7,000 10	8,500 9	17,000 4
17,000 8	15,500 9	13,000 10	30,000† 3	32,000 3	17,000 8	14,000 10	17,000 8	24,000 5	18,500 7	19,500 7	15,000 9	18,000 7	27,000 4
34,000 7	40,000 4	58,000 2	55,000 2	50,000 3	24,000 9	32,000 8	30,000 8	46,000 3	37,000 5	36,000 6	38,000 5	37,000 5	45,000 3
1,100 7	1,900 2	1,800 2	1,100 7	—	—	—	—	1,400 5	1,850 2	1,500 4	2,050 1	1,850 2	875 9
1.6 8	2.4 6	5.8 2	7.7 2	2.0 7	1.55 8	.60 10	0.46 10	4.2 3	2.6 5	2.6 5	2.3 6	3.2 4	2.2 7
0.6 8	1.3 6	4.6 3	2.6 4	.67 8	.60 8	.35 10	0.44 9	1.4 6	1.3 6	1.2 6	1.3 6	1.7 5	1.8 5
105	105	97	110	103	92	105	105	106	112	106	102	105	110
1.35	1.34	1.18	1.70	1.35	1.35	1.35	1.35	1.34	1.34	1.35	1.33	1.35	1.35
1.3 6	0.9 4	0.3 2	1.75 8	2.0 9	0.9 4	0.4 2	0.45 2	1.0 5	0.80 4	1.0 5	0.9 4	0.95 4	1.5 7
50 8	—	25,000 1	—	.20 9	500 4	10,000 3	25,000 1	25 9	—	—	—	—	—
650 2	—	450 4	—	400 4	500 3	500 3	850 1	500 3	—	—	—	—	—
.045 7	—	.027 3	—	.049	.042 6	.028 3	.029 3	.09 10	—	—	—	—	—
4.8 3	—	3.8 1	—	5.9 8	5.5 4	4.3 2	4.4 2	5.7 8	—	—	—	—	—
.22 4	—	.10 1	—	.30 7	.23 5	.12 1	.13 1	.51 10	—	—	—	—	—
—	—	10 6	—	—	—	—	—	—	—	—	—	—	—
1, 2, 3 N, C	1, 2, 3 N	1, 2 N	2, 3 N	2, 3 N, C	2, 3 N	2, 3 N	1, 2, 3 N	1, 2 N	1, 2, 3 N	1, 2, 3 N	1, 2, 3 N, B	1, 2, 3 N, B	1, 2, 3 B
1/16"–5"	1/4"–10"	1/4"–1/4"	1/32"–2"	.010"–1/4"	.010"–1/4"	.010"–1/4"	1/4"–1/4"	1/32"–3"	1/32"–3"	1/32"–3"	1/16"–6"	1/4"–2"	1/32"–5"

**Across grain figures for impact approximately one-fourth of these data. All tests were made in accordance with the latest A.S.T.M. test specifications.

† 1. = 36" x 36" 2. = 36" x 48" 3. = 48" x 60" 2 N = Natural B = Black C = Chocolate

Paper Converting
MACHINE COMPANY

Designers and builders of machinery for converting paper products.

TOWELS
- Folders - Rotary
  - Multifold
  - Standard Fold
  - Lapped Multifold
  - C Fold
- Winders
- Hardwound Winders
- Embossers
- Printing Presses
- Packaging Presses
- Wrapping Machines
- Banding Machines

TOILET TISSUE
- Folders - Rotary
  - Standard Fold
  - Double Fold
- Winders
- Embossers
- Hardwound Winders
- Roll Wrapping Machines
- Packaging Presses
- Package Sawing Units
- Conveyors

NAPKINS
- Folders
  - Quarter Fold
  - Dispenser Fold
  - Double Transverse Fold
  - Corner Folds
  - Interfold
- Embossers
- Scalloping Machines
- Box Closing Machines
- Bundling Presses

DECORATED NAPKINS
- Multicolor Printing Presses
- Die Inkers
- (These units incorporated with embossers and folders)

WAXED PAPER
- Folders - Rotary
- Winders
- Slitters
- Printing Presses

FACIAL TISSUES
- Folders
  - Continuous C Fold
  - Transverse Fold
  - Interfolders
  - Pocket Package Fold
  - Quarter Fold
- Winders
- Embossers
- Carton Closing Machines

PAPER HANDKERCHIEFS
- Folders - Rotary
- Embossers

PRINTED PAPERS
- Multicolor Rotary Presses
- Roll Delivery
- Sheet Delivery
  - Aniline Ink
- Oil Ink
- Metal Plate
- Rubber Plate

CREPE PAPERS
- Creping Machines
  - Tissue
  - Waterproof
  - Kraft
- Collapsing Reels
- Winders

SEAT COVERS
- Rotary Folders for Flat Sheets
- Winders for Rolls

SPIRAL CORES
- Forming Machines
- Automatic Cutoff Units
- Recutters

GUMMED TAPE
- Gumming Machines
- Printing Presses
- Winders
- Breakers

GIFT WRAP
- Folders - Rotary
- Winders
- Printing Presses

TABLE COVERS
- Folders - Rotary
- Printing Presses
- Embossers
- Winders

CUPS, PLATES, CARTONS
- Printing Presses
- Blankers
- Rotary Punching Units
- Indexing & Feeding Units

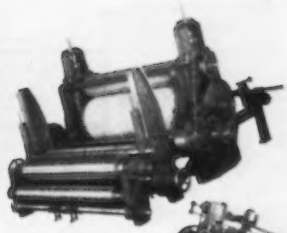
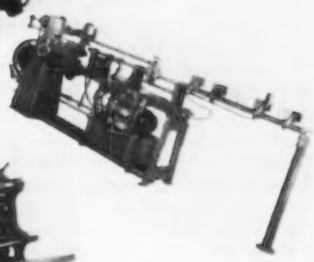
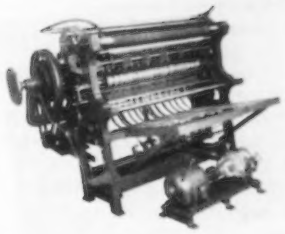
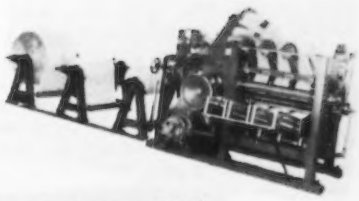
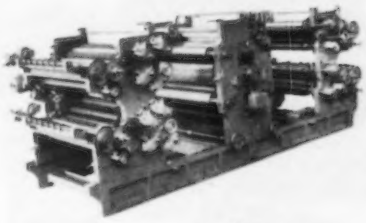
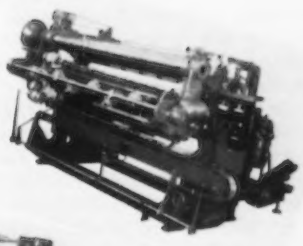
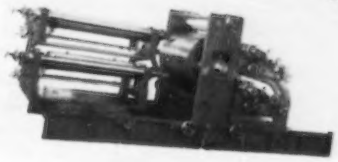
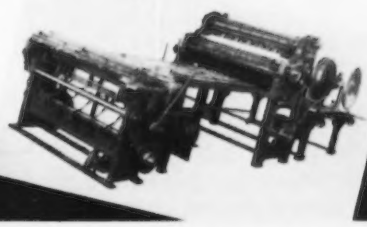
BAGS
- Printing Presses
- Embossers
- Shopping Bag Handle Machines
- Bundling Presses

LABELS
- Printing Presses
- Sheeters
- Winders

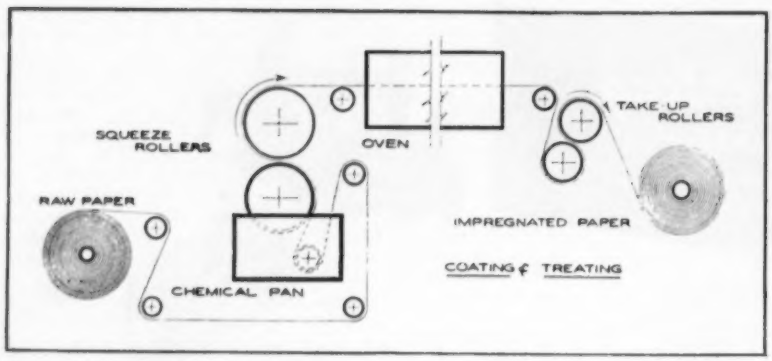
CHECKS, INVOICES, BUSINESS FORMS
- Printing Presses
- Perforators
- Winders
- Rotary Punching Units
- Tabulating Machines
- Collators
- Intermittent Cutoff Units

BOOK COVERS
- Printing Presses
- Perforating
- Sheeting
- Embossers

SPECIAL MACHINES
- Tray Covers
- Cross Cording Machines
- Special Rotary Folders
- Boring Heads
- Collapsing Reels
- Roll Brushers
- Special Rewind Units
- Unwind Stands

PAPER CONVERTING *Machine Company* GREEN BAY, WISCONSIN



Figure—Impregnation process.

tained in the paper, which is completely saturated. The web goes from the squeeze rollers through an oven where the resin is dried and the polymerization advanced to give the desired properties in the final stage of the resin cure. This is a critical operation because too little conversion will result in excessive flow of the resin in pressing, with the possible loss of weight or insufficient resin remaining in the paper and the over advancement of the resin can result in insufficient flow with poor lumination. Testing at this stage is critical and close control is maintained on resin content of the paper, the amount of flow of the resin in the paper and the amount of volatile matter left in the paper.

Some other methods of coating which are worthy of note are reverse roll coating. This type of coating allows an even amount of resin to be applied on the surface of the web. The web moves in the opposite direction from the coating roll and the varnish is transferred with little pressure. Kiss coating is used where it is not necessary to completely saturate the paper. Dip-squeeze coating allows the resin to be applied from one side of the web after which the web is passed through squeeze rollers where the resin is forced into the paper, resulting in a coated impregnated sheet. Most of these methods are primarily for coating paper, however, laminating in most instances require the complete saturation of the paper.

In addition to the method shown in Figure 1 and described above, there is another method, namely the dip-flow method, which consists of passing the web through a tank filled with the liquid resin and then running the web in a vertical direction. Depending upon the specific gravity of the varnish, the porosity of the paper and the evaporation rate of the solvents, as well as the speed of treating, the desired properties of the treated paper are obtained.

After the web has been saturated, it is fed into a drying and curing oven. The oven is usually steam heated, although electrical heating is also used. After the web has been dried in the oven, it is rewound.

Sheeting

The rewound treated paper is then taken to a rotary cutter, or sheeter, where the paper is sheeted to a desired length. The web may also be slit at this operation. After the sheeting operation, the material is ready to be pressed.

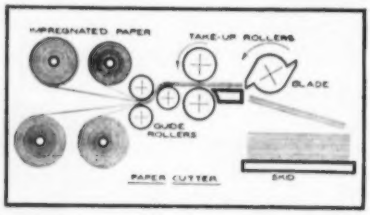


Figure 2—Multi-roll paper cutter.

Pressing

Pressing is the third step in the conversion of the varnish, which has been placed in the paper, into a homogeneous laminated board. Multiple opening hydraulic presses capable of exerting pressures in excess of 1000 lbs. per sq. inch are used in the pressing operation. In most instances the platens are cored for the passage of steam, which heats the platen. This heat, together with the pressure, laminates the material. In addition to the steam, electricity is also used for heating. Di-electric, or high frequency heating, is employed in some instances, generally where thicker boards are being pressed. This method has some advantages over steam heating, although it is costly.

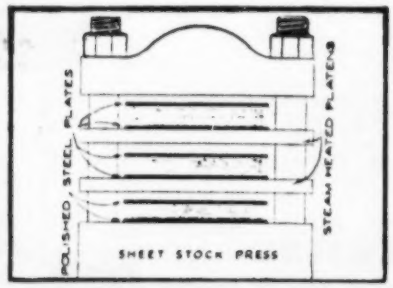


Figure 3 — "Build-up" in hydraulic press.

The press cycle, that is the heating and cooling of the boards, will vary depending upon the amount and type of material being pressed at one time. The length of cure cycle effects the properties of the board. An under cured board will not meet the specifications for the particular grade intended, but will have a tendency to be relatively soft. On the other hand, an over cured board will be brittle and will not measure up to the specifications set for strength, etc. In pressing flat sheets it is usually necessary to cool the board prior to their removal from the press. Cooling prevents the boards from blistering, warping, or becoming dull on the surface. On the other hand, the pressing of molded forms is somewhat different; for in the place of using flat steel plates, a mold is employed. The mold is machined to the desired contour and tolerances. Although the pressing of molded forms can be performed as already described for flat sheets, usually a fast cycle method is used in which the piece is removed hot. In order to keep the piece from becoming blistered when it is removed hot, a method of relieving the volatile material in the laminated piece has been developed. This method consists of opening the press momentarily after the material has become hot to allow the volatile material to escape. When the volatile material escapes, the press is then closed and the cure cycle completed.

Tubes and Rods

Tube rolling was obtained early in the history of the industry as a means of obtaining insulation for the electrical industry. Paper used in tube rolling is usually treated with a dip pressure method of treatment, except that after the paper leaves the squeeze rolls a doctor blade scrapes one side of the paper relatively free of resin. This leaves the paper completely saturated with the resin and a heavier layer of resin remaining on one surface. The paper is then dried in the oven. As you can see from the sketch below, a tube rolling machine consists of backstand on which the treated paper will be placed, tension rollers, a set of steam heated rollers over which the paper will be passed to be wound on a steel mandred and a pressure roller to exert some pressure between the steam heated rollers and the pressure roller.

Tubes are rolled on steel mandrels. The size of the tube depends upon the amount of material placed on the mandrel. Two types of tubes are produced —rolled and molded. Rods are also manufactured on the tube rolling machine. In the case of molded rods and tubes, the material properties are nearly identical with those of flat boards in the same grade. Rolled tubes are somewhat lower in density and more porous in structure than pressed tubes. After the tubes have been rolled on mandrels in the tube rolling machine, they are not completely cured; and the curing must take place by the addition of heat. If the tube is to remain as a rolled tube, it is placed in an oven and allowed to cure there for a given period of time, depending upon the size of the tube. The resin is completely cured in this manner. If the tube is to be pressed, the mandrel is allowed to remain in the tube and the tube is pressed in a mold which is designed to take that specific size. They are then pressed the same as a flat sheet would be pressed under about the same hydraulic pressure. After the tubes, either rolled or molded, are removed from their final curing process, the mandrels must be extracted from the tube. This is done on a mandrel pulling machine. Rods are made by first removing the mandrels and then collapsing the uncured tube and finally curing it under heat and pressure in molds.

Paper

It is safe to say that kraft paper is used more extensively than any other type. Kraft is a very cheap, strong paper. It can be made in a saturating grade and possesses high strength properties, which are essential in laminating. Some general specifications for kraft paper are as follows: that the paper contain no loading or sizing and that it be free from foreign particles which would interfere with the quality and the appearance of the finished product. Changes in the methods of cooking the wood, etc., should be considered as a change in the furnish. The formation of the paper shall be uniform in texture, density and finish and shall be free from hard lumps, light areas and pitch spots. Thickness is of major importance for this quality of paper and the tolerances are held very closely. It is also essential for laminating papers that complete penetration or saturation of the paper be obtainable. Hard spots, which will not readily take resin, might result in rejected material after pressing because those foreign particules which are causing the hard spots might cause blisters in the finished laminate. Other types of paper consisting of 35 per cent cotton linters and 65 per cent kraft, or even 100 per cent cotton linters, are used in various industrial applications. In pressing flat sheets many varieties of paper may be used. However, for tube roling and molded applications of laminating, special qualities in paper are required. In molding paper base laminates, kraft paper is used more extensively than any other. Primarily because it has a high strength and low cost factor.

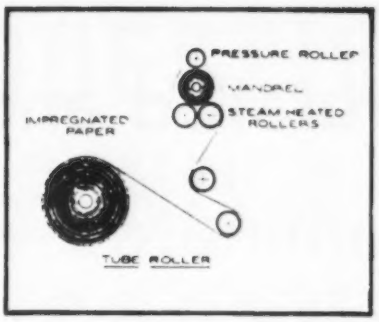


Figure 4—The tube rolling operation.

The paper used in pressing decorative sheet laminates is highly specialized. A decorative laminate is composed of a thin sheet on the surface, which is called an overlay sheet; a liner sheet, which is either white or colored and is generally printed; several sheets of kraft and a sheet of glassine, or a separator sheet. The overlay sheet is a grade of saturating paper used as a protective top layer in the decorative high pressure laminate. The basic fibers are 100 per cent Alpha-cellulose or rayon. This sheet contains no loading or sizing and the thickness is aproximately 4¼ mills. The sheet must have a clear, clean appearance. There must be no foreign particles which will mar the appearance of the finished laminate. It has been found over a period of time that only the cleanest pulps may be used for the manufacture of this sheet. Since the finished sheet is to be used as a decorative material, it must be given a very critical inspection. This sheet is impregnated with a clean melamine-formaldehyde resin and when pressed onto the finished board, this sheet becomes practically transparent. Therefore, any foreign material in the sheet will stand out sharply. This sheet may also be furnished in colors, which impart a different shade or color to the decorative laminate. The liner sheet used in pressing decorative laminates can either be white, a solid color, or a printed sheet either on white or colored paper. The basic fibers of this sheet are alpha-cellulose. The base pigment is zinc sulphide for light papers and lithopone for dark papers. The formation must be uniform and free from pronounced wildness. Basis weight varies somewhat with manufacturers, but is usualy approximate 100 lbs. per ream. Thickness and control of formation are of the utmost importance. This sheet is usually approximately 8½ mills thick. Color matching is also of great importance in this sheet, and it is unfortunate that the manufacturers of laminated materials cannot accept the color matching in the paper itself, but must insist that a sample of the paper be laminated so that colors can be matched after the material is laminated. The finish on the sheet must be smooth and clear for accurate printing.

This paper must also be clean and free from slime spots, wrinkles, scabs, calender cuts and dirt specs. As in the overlay sheet, dirt specs and other foreign material are to be held to a minimum, as large particles of dirt will cause rejections in the finished sheet.

It is possible to remove dirt from the overlay sheet and the removal of some dirt from the liner sheet can be accomplished. However, if the dirt is completely imbedded in the liner sheet, it is impossible to remove the dirt without picking a hole in the liner sheet. This hole will result in a rejected finished panel.

Physical Testing

Electrical characteristics were originally the main consideration in testing laminates; but the use of laminates has extended to other industries and mechanical properties have assumed greater importance. Mechanical testing follows closely testing used on metals, although the nature of the material and structure are such that there is some difference in the testing methods. In addition to mechanical tests such as impact strength, compressive strength, tensile strenth, flexional strength, modulus of elasticity in tention and dimentional stability, laminatings materials are also subjected to certain electrical and heat tests for which this material is notably found good. Some of these tests are di-electric strength, power factor, insulation resistance, di-electric constant, water absorbtion, thermo-conductivity and thermo-expansion. In decorative laminates, hardness and abrasion resistance are also important tests. Abrasion resistance is usually determined by a Taber abrader in which the loss in weight after the speciman has been subjected to abrasive wear under standard conditions is determined. This test is usually conducted on decorative materials to determine the amount of wear the surface of the decorative sheet will stand before the pattern becomes obliterated.

Asphalt Saturated and Laminated Paperboard

Roman J. Suess and Roger E. McVickar

Otsego Falls Paper Mills, Inc.

One usually thinks of converting as changing a product into a more useful form by cutting into special shapes, coloring, folding or scoring, or combining it with other products. Asphalt saturating of paperboard is such a transformation, as there is a definite change in outward semblance and in composition. A soft and very flexible sheet of paperboard is passed through a bath of molten asphalt to produce a hard, black, very rigid board that is completely impervious to moisture.

R. J. Suess

R. E. McVickar

Roman J. Suess, Secretary and Resident Manager, Otsego Falls Paper Mills, Inc., Otsego, Mich. was employed by the Menasha Wooden Ware Corp., Menasha, Wis., as an accountant in 1926. He continued there in various capacities until early in 1940 when the company transferred him to Durham, N. C. to assist with the establishment and operation of a corrugated box plant. Late in 1941, at the request of his employers and the Management of Otsego Falls Paper Mills, with whom they are associated, he was transferred to his present position. . . . Roger E. McVickar, Technical Director, Otsego Falls Paper Mills, Inc., was born and raised in Norwood, Pa. a suburb of Philadelphia. He graduated from Glen Nor High School and attended Drexel Institute, transferring to Western Michigan College, where he received a B. S. degree in Chemistry. He spent one summer working for Otsego Falls, and one summer at Scott Paper Co. in their Technical Control Laboratory, and is currently employed by Otsego Falls as Technical Director.

The Common Uses

An endless number of uses can be found for asphalt saturated and laminated paperboards, but to date the following have been commercially exploited at Otsego Falls:

Building Boards— Building board of many sizes and caliper are always in demand. They are used to cover old structures and act as a base for new siding or for temporary partitions, and even for complete structures such as chicken coops, etc., where initial cost must be low.

Splash Boards— Asphalt boards lend themselves readily for use as splash boards under modern house trailers. Their resistance to moisture is of paramount importance, but they also act as sound deadeners and cut out much of the noise arising from rough roads or stones bounding from the tires.

Expansion Joints— Asphalt saturated and laminated strips are used as expansion joints in some of our modern concrete highways which, without these joints, would be cracked to pieces in a matter of months due to expansion and contraction from temperature changes.

Panelboards— Most of the newer cars on the road today are good looking, comfortable and warm, thanks to panelboard. The asphalt board is die cut to size, upholstery is laminated or sewn on and the resultant product is put on the inside of the car doors. In addition, the kick board (area around the foot pedals) is often an asphalt board as is the lining on the sides of trunk compartments.

Tote Boxes— These boxes are used for storing or moving about small parts, such as nuts or bolts of one size, etc., usually in conjunction with an assembly line.

Tubular Shell Containers— During World War II and in the present war, thousands of shells were shipped overseas in asphalt laminated tubes called shell containers to protect them from the elements. In addition, flat pieces of asphalt board were bumped into shapes and nailed over the packing slips on shipping cases and crates to protect them from the weather and mechanical abrasion. To protect larger pieces of equipment, asphalt board was incorporated in created crate boxes (wooden frames with asphalt board tacked on).

The asphalt laminated boards commonly made by Otsego Falls are 40

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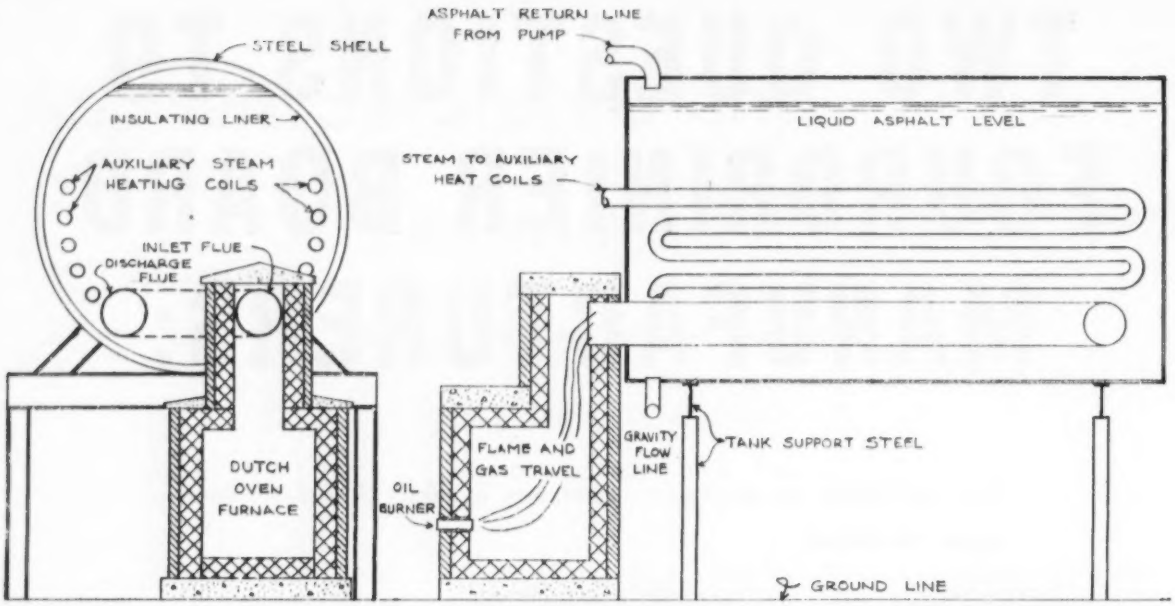


HEATED ASPHALT STORAGE TANK

FIG. 1

OTSEGO FALLS PAPER MILLS, INC.

points (.040 inches) through 125 points (.125 inches) in thickness, built up from 2 to 5 plys of paper, with 80 point and 100 point being in greatest demand.

Use Requirements

The main requirements, as we can see from the uses already listed, are waterproofness and stiffness, or rigidity, but there are some hidden ones too. The board usually should be light in weight for its rather high caliper, easily penetrated by stitching and nailing, yet should hold nails as cloth or wood does, should have good workability for cutting to size, and above all, have a low cost of manufacture as it is very often for temporary use only.

Limitations

There are some drawbacks when using asphalt boards, but the uses are created or found where these factors are of minor importance. Upon exposure to air, sunlight and moisture for long periods of time, asphalt boards tend to change from black to mud brown in color due to:

1. Evaporation of the volatile constituents.
2. Chemical oxidation.
3. Formation of "free carbon" by the loss of hydrogen during chemical oxidation.
4. Possibly polymerization or "spontaneous hardening."
5. Filling of the voids with water.

If organic solvents are used to remove spots, etc., from car panels, there may be some "bleeding" of the asphalt into the upholstery.

When laminating different kinds of paperboard, care must be taken to see that the individual plys do not expand unevenly or shrink unevenly after bonding has taken place, otherwise the plys will separate, rigidity will be lost, water will penetrate more easily between the plys, and waterproofness will be materially lowered. Hard board of this kind does not lend itself to good scoring and folding.

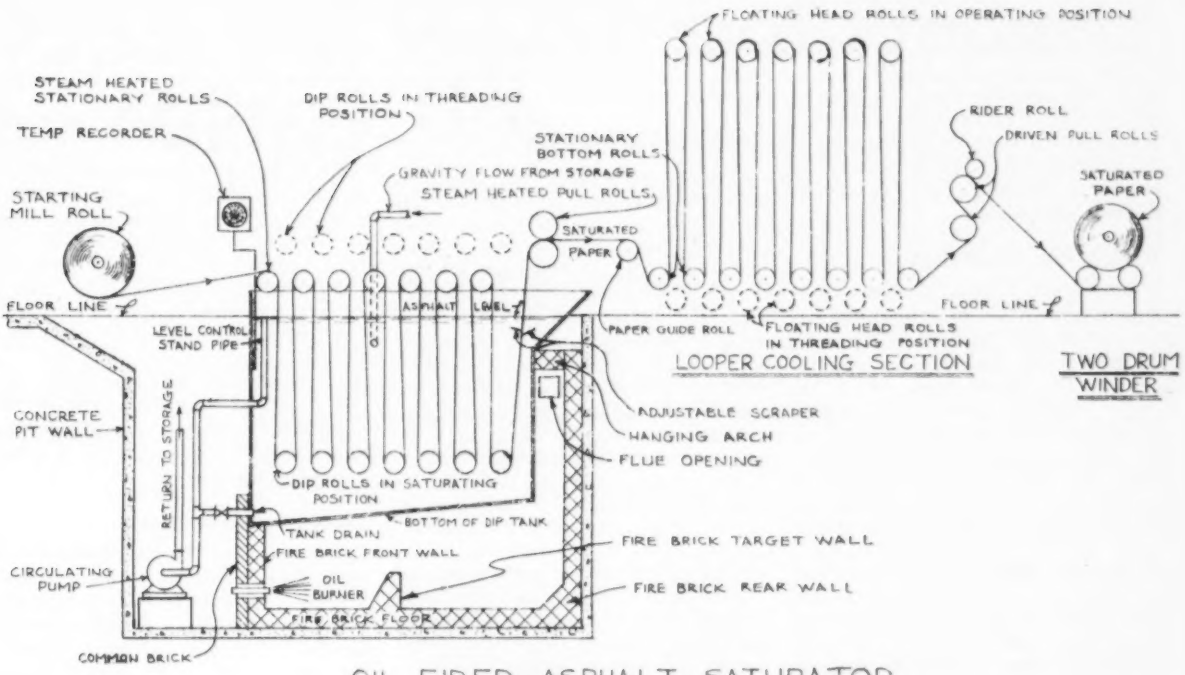
Saturating Paperboard

Essentially, saturating with asphalt consists of putting a sheet of paperboard into molten asphalt, removing the excess, and cooling the resultant sheet.

Asphalt is received in insulated tank cars, heated further by passing steam through heating coils in the car and pumped to the asphalt storage tank, which is also heated with steam coils. When ready to start operation, asphalt is pumped into the saturator and heated to approximately 465° F with an oil burner.

The paper is threaded through the two sets of rolls and operations are ready to start. One set of rolls is stationary and steam heated; the other set, called dip rolls, may be raised for threading the sheet and then lowered into the asphalt to have the maximum area of board exposde to the hot asphalt in order to obtain fast but thorough saturation at the speed required for economical operations. These rolls are not heated. There are saturators where the sheet passes straight through the saturant instead of up and down. The excess asphalt is removed by steam heated squeeze rolls or doctor blades, or both. The saturated board is air cooled and wound into rolls. If the sheet is not cooled, the heat carried over can cause spontaneout combustion in the roll, or melt the asphalt to such a degree that the layers stick to each other and upon cooling cannot be easily separated. Being impervious to water, the saturated rolls are stored outside until needed. Excessive moisture in the original paperboard will cause foaming in the asphalt bath, which can become a serious problem, and the temperature may be lowered to such a degree that saturation is not accomplished.

The degree of saturation is varied to suit the specifications by changing speed and number of dips into the asphalt. The degree is expressed as a percentage, i.e., the unit weight of the



OIL FIRED ASPHALT SATURATOR

FIG 2.

OTSEGO FALLS PAPER MILLS, INC.

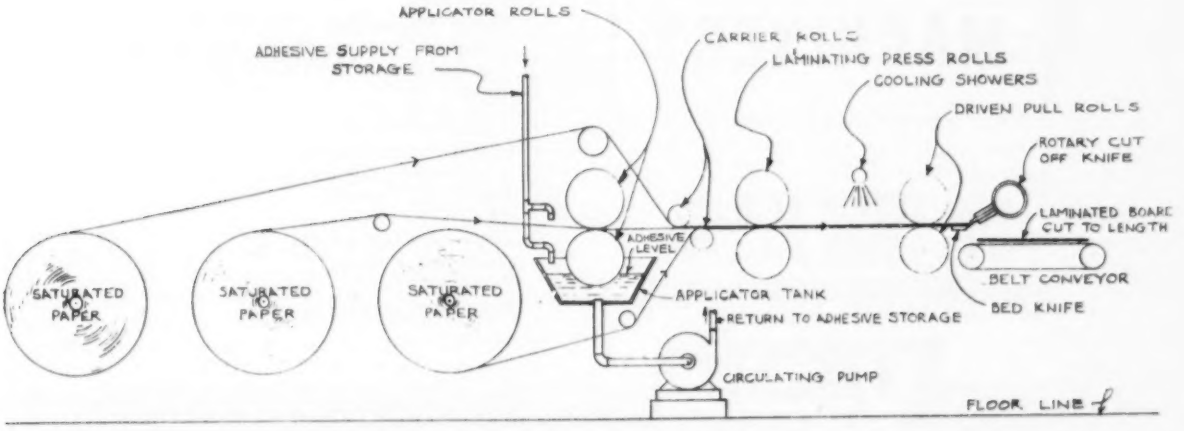
asphalt pick-up divided by the unit weight of the unsaturated board and expressed as percent. One hundred per cent saturation is reached when the weight of the original paperboard is doubled after saturating; it is therefore possible to have more than 100 per cent saturation.

Laminating Asphalt Saturated Paperboard

The desired caliper determines the number of plys to be used for the lamination. There must be a roll for each desired ply in a continuous lamination, and the plys may or may not be saturated, according to the specifications. For our purposes most of the board used is saturated.

For the adhesive, various products can be used besides molten asphalt, but asphalt gives an added waterproof barrier which is a great asset in most cases. In addition to asphalt, a starch-latex adhesive is used and its use is protected under U. S. Patent No.s 1,689,812, 2,073,894, and 2,197,822.

The individual plys are threaded through the laminator, the adhesive asphalt pump started, and the laminator itself started. The adhesive is applied to the top surface of the center plys by flowing it on and squeezing off the excess. The bottom of the plys are covered by using an adhesive transfer roll. This roll runs in a trough containing the adhesive and carries it up onto the sheet. The amount of adhesive is regulated by the pressure between the sheet and the transfer roll. The laminated plys are passed through a series of squeeze



PAPER BOARD LAMINATOR

FIG 3

rolls and cut to rough lengths by a rotary cut-off knife. All of the rolls on the laminator are steam heated to keep the adhesive from sticking to them. If the rough size is satisfactory, the laminated board is shipped out as is. Otherwise it must be trimmed to size as a finishing operation in the trimmer department.

Types of Paperboard Used

Fourdrinier boards or paper lend themselves readily to saturating, and also two ply cylinder board. The multi-cylinder boards are very low in saturating and seldom used. A bulky, highly absorbent sheet is the easiest to saturate but does not always meet the other qualifications. Consequently, board of high density is used alone and in combination with bulky boards. Neutral sulphite semi-chemical board lends itself to easy saturability, and therefore is extensively used alone and in combination with kraft to obtain the best results. Caliper is an important specification for the boards used in laminating since it must be uniform in order to maintain a specific caliper on the finished board.

About the only drawback has been mentioned before and that is in cutting the laminated board. If the dimensions require close tolerances, a separate trimming operation must be carried out and that involves extra handling and time.

Testing of Raw Materials

The board must be constantly checked for caliper, porosity, and rate of absorption. Caliper testing is well known to most or all of you, consisting merely of measuring thickness. Porosity testing determines how rapidly 100 cubic centimeters of air passes through an area of one square inch. Absorption is tested by immersing one end of a strip of the board cut 2.5 cm wide in xylol and noting the time it takes the xylol to reach a point 3 cm above the liquid level.

The asphalt used for saturating is a petroleum base, steam blown product and must meet two requirements—melting point and penetration. The melting point is the temperature at which asphalt becomes sufficiently fluid to drop from the thermometer used in making the determination under definite prescribed conditions. Penetration is defined as the consistency of a bituminous material, expressed as the distance that a standard needle vertically penetrates a sample of the material using a 100 gram load for 5 seconds at 77° F. The unit of penetration is 1/100 of cm. By maintaining the specifications for these two tests, uniformity of supply is assured.

To obtain the greatest rigidity in the saturated board, 180° F.-190° F. melt point asphalt with a penetration of 0-1 is used. If rigidity is not necessary, asphalts of lower melt point and higher penetration can be used. The adhesive asphalt which is air blown has a melt point of 212° F.-225° F. and a penetration of 13-28. The two asphalts are not compatible and cannot be mixed.

If foaming in the saturator is encountered, the moisture content of the paperboard should be checked to see that it does not exceed the 6-7 per cent normally present.

Testing the End Product

The saturated board is checked for the degree of saturation by weighing a sample before and after saturating. On an unknown board this may be calculated by weighing a sample, extracting the asphalt with carbon tetrachloride, and re-weighing the sample after evaporating the solvent. Also the laminated board is checked for caliper and size and the amount of adhesive pick-up.

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Paper and Paperboard Products for Military Use

E. T. A. Coughlin

Former Chief Paper and Paper Products
Section, Research and Development Div.,
Office of the Quartermaster General, Washington, D. C.

In this talk we can only briefly cover this subject by referring to the splendid development work carried on to completion by a number of task groups. Men from each segment of the paper and paperboard industry have worked with responsible military leaders to bring about the changes that were necessary in the design and structure of paper and paperboard products used to aid in the successful culmination of World War II.

It would be extremely presumptuous on my part to attempt to delineate the tremendous effort expended to improve the various grades of paper and paperboard items for military use. Most of this work has been recorded, published in one form or another, and is available to anyone with a direct interest.

Central Procurement

In May, 1949, the Munitions Board, in following its program of simplification of procurement activities of the Department of Defense, allocated to the Department of The Army the responsibility for the purchase of all paper and paper products required by the Army, Navy and Air Force. The Secretary of the Army promptly delegated this responsibility to the Office of The Quartermaster General.

To paraphrase the adage "An army travels on its stomach," we might add that it could not even move without paper. During the emergency years of World War II, the overall impact of the Army's purchases on the total production of the industry was small, amounting to only 3 to 4 percent of the total capacity of the U.S. mills; yet the Army's demands for a much greater percentage of the production of kraft and other packaging papers, created shortages and production problems in this particular field.

Edward T. A. Coughlin received his B.S. from the University of Maine, Orono, Maine in 1913; his Chemical Engineer, Professional Degree, University of Maine, Orono, Maine in 1916. From 1914 to 1918 he was Chemist and Coating Superintendent, Monarch Paper Co., Kalamazoo, Mich.; 1918 to 1924, Technical Director and General Coating Superintendent, Allied Paper Co., Kalamazoo, Mich.; 1924 to 1925, Mill Manager, Miami Coated Paper Co., Franklin, Ohio; 1925 to 1927, Mill Manager, New Jersey Coated Paper Co., Montclair, N. J.; 1927 to 1929, Consultant, W. F. Hall Printing Co., Chicago, Ill.; 1929 to 1930, General Manager, Deerfield Glassine Co., Monroe Bridge, Mass.; 1930 to 1939, Industrial Engineer, Pettengill Inc., Chicago, Ill.; 1930 to 1939, Vice President and Manager, Paper Laboratories, Inc. (Subsidiary of Pettengill, Inc.); 1939 to 1946, Service Manager, Bryant Paper Co. Kalamazoo, Mich.; 1946 to 1948, Consultant, C. T. Main Co., Paper Mill Engineers, Boston, Mass.; 1948 to 1949, Consultant, St. Regis Paper Co., Deferiet, N. Y.; 1950 to August 1953, Chief Paper and Paper Products Section, Research & Development Division, Office of The Quartermaster General, Washington, D. C. Mr. Coughlin died on Aug. 20th of this year.

The Department of Defense is probably the world's largest purchaser of paper and paper products, ranging in volume estimated between 100 million and 150 million dollars per year.

This volume will include practically every grade of paper that is produced. It would be much simpler to check from a dictionary of grades of paper, those particular items that are not used, than to attempt to list the ones that are used.

Again, it would be a difficult task to list the various grades in the proper sequence of importance. They are all important, from high grade rag content bond to the lower qualities of newsprint and mimeographs.

During the early phases of the Korean emergency the previous experiences were recalled and definite allocation or set aside orders were issued to ease the difficulties of procurement. Estimates of 5 to 10 percent of the industry's production were established for military and Government uses.

Military Packaging Requirements

Even this figure appears rather trifling compared to the annual paper industry tonnage of 24 to 27 million tons, until one realizes other impacts of a 50 to 60 billion dollar military budget. This budget calls for materials of all kinds that must be packed, packaged, and crated for safe transport to the point of use or storage.

It has been established that a minimum of 6 percent of the cost is required for these protective features, or at least 3 billion dollars. And, if we assume 10 percent of that figure to be paper and paperboard products, or 300 million dollars, we have a basis of thinking about paper in a military sense. It becomes evident that the Department of Defense is the world's largest buyer of paper.

The paper industry for years has enjoyed a certain percentage of export business which required special attention to the method of packing and packaging. From my own experience with paper exported to South America, Cuba, China, and to the Philippines, it was a rare occasion that we did not receive a report of loss or damage at port of arrival.

When you realize that such damage occurred through normal channels of handling and transport by experienced and trained manpower, it is not surprising that material for the military in far flung ports and depots and camps throughout the world arrived in damaged, if not useless, condition. Picture, if possible, the number of individual handlings, from mill, to truck, to cars, to ports, to ships, to barges, to docks; and then possibly dumped overboard and floated to shore, to be later piled in the open, loaded on jeeps or trucks, and rattled over rough terrain to the point of use. The time interval might be at least 3 months and possibly 12 to 18 months or longer, before the package is opened (if it is still intact) and conditions of contents can be determined.

Since your chief interest is in converting paper and paperboard, you can readily see what an opportunity was presented for the development of specially treated materials, combinations of paper, paperboard and waterproof materials; combinations of cloth, films and greaseproof materials; and combinations of paper, foil, plastic resins, to promote barriers to water, grease, moisture vapor and other gases.

A discussion of paper and paperboard for military use is, primarily, a discussion of all phases of these industries and all their varied products. Aside from the deluxe printing and writing grades, practically every type paper or paperboard product is used by a modern military establishment. Papers for military use have the same basic properties as papers for ordinary commercial consumption.

However, in addition to the large tonnage of regular commercial grades used by the Armed Services, there is a need for highly specialized papers to meet definite military requirements. The inherent differences between these military sheets and the regular commercial grades are more of degree—or of a combination of properties not usually expected for ordinary usage. The production of these products involves the usual skills and processes utilized by the paper mills and converting plants *plus* the additional skill and knowledge necessary to blend various raw materials and adjust the different elements of the processes to the exactness required to get the desired combination of properties.

Military packaging must be adequate to meet usage not expected in normal commercial channels. Emergency shipments from stock piles must meet extreme conditions of weather—hot or cold, wet or dry. They must hold up against rough handling—far worse than your Christmas parcel post packages, and on top of all this, must possess above average permanency. Certain supplies, repair parts, ammunition and the other multi-requirements of a modern defense Army, Navy or Air Force must be kept ready for emergencies—and the utility of most of these supplies is no better than the adequacy of their packaging. Loss due to poor packaging materials is not just the cost of the packaging material, but also includes the loss of the contents, plus the time and loss in efficiency of personnel and other materials in the emergency.

Undetected damage due to inadequate packaging of a spare part needed for emergency repairs can immobilize a key vehicle or critical equipment at a spot and time when many lives are at stake. There is no time for leisurely tinkering or kid-glove handling when enemy guns are blasting away.

The very nature of the problem of supplying defense packaging requirements dictates the use of generally available basic equipment and materials.

Converting Increases Utility

Additional properties, or further development of properties not possible or feasible to put into the base paper sheet, must be incorporated by a subsequent converting operation. It is at this point that commercial grades and some military grades differ in the materials and operations employed in the manufacturing processes.

The requirements for military papers are stripped down to the essentials of use properties. Deluxe trimmings or finishes that add no extended protection or life to the package have no place in such packaging. Fancy finishes add to the cost and may even detract from the use value. For example—the high polish or glossy finish on some of the papers created for packaging elegance have too much light reflectance if used in a war zone. Such little things as reflected light from glossy surface can reveal an encampment to the enemy.

However, some of the chemicals or processes normally used for specialty papers add certain protective properties not readily obtained by normal methods. Adaptations of formulae and equipment for these applications are often necessary. Considerable ingenuity is required to accomplish the desired results.

The only way to highlight and illustrate the paper and paperboard problems connected with military procurement is to sketch, briefly, some of the differences in a few of the items.

Food Packaging Problems

The fact that food packaging is a vast problem in itself is evident to anyone looking around the modern supermarket. The variety of shapes, sizes, weights, forms and amount of protection required extends ad infinitum. Now add to these normal problems the problems of storing and distributing food to small isolated groups or individuals scattered in unusual places and extreme climates—together with protection against contamination from rats, insects, fungi, viruses and microbes.

Getting down to the effects of variations in paper properties with which you are more familiar, it has been noted that a bag stock that is very satisfactory in holding 10 pounds of potatoes may tear or burst more easily holding 10 pounds of rice, and an entirely different sheet is better for flour or salt under identical transport handling. Sufficient data have not yet been collected to prove just what combination of physical properties is the most indicative for each use, and what ratio of properties is a safe index of usability. What really complicates setting up a specification for a sheet with a realistic safety margin is the fact that occasionally two sheets with comparable average burst, tensile and tearing test results may behave differently on impact or shock. Although some progress is being made in studying use properties of paper, there is still a wide open field for investigating and pinning down the significant physical properties and finding methods for measuring them. As every paper man knows, time is of the essence in a paper mill, and very little can be done to improve strength after the formation stage, although many things can decrease strength in further processing. Every paper man also knows that the development of almost every strength property is accomplished at the expense of some other desirable property—for example, increasing burst accompanies decreasing tear. It comes down to a question of blending several stocks developed for a specific purpose and then getting them over the machine. Experienced mill men can assure you that sometimes this is quite a trick.

Strength is only one of the problems in food packaging. Either excess moisture loss or absorption by food

can ruin it. Absorption of foreign vapors or flavors can be distasteful even when not harmful. Sealability and workability on automatic packaging machines are also important factors.

Special Uses

Since paper is made from fibers and an untreated sheet of this construction is naturally absorptive, it is obvious that additional treatments are necessary to give paper more of the desired properties. The converting operations of impregnating, coating and laminating with all their attendant problems increase the necessity for additional tests to evaluate effectiveness.

The baling and packaging of clothing present a somewhat different set of problems. Flexibility and waterproofness are important. Asphalt laminated and creped sheets have many of the desired properties for baling sheets at a low cost, but unfortunnately the asphalt adhesive has an affinity for the more effective mothproofing agents and migrates into the clothing. Ugly, unsightly stains result. As a result, more expensive plastic coated or laminated sheets are less costly in the end.

Temporary and emergency paper-based tents and tarpaulins require strength and waterproofness. These paper substitutes for canvas have given effective short-term shelter in some places where canvas was unobtainable or urgently needed for longer-term storage.

Disposable paper trays, plates, cups, napkins, sheets and many other items have made possible more civilized comfort and sanitation to military personnel in spots where the conventional materials would have been completely impractical. Each of these items presented special problems in developing manufacturing techniques, materials and required use properties.

Absolute protection of metallic surfaces against rust and corrosion has always been a major problem for both industry and a modern armed defense. Inspection, cleaning, or polishing can be done more leisurely and with better working facilities in industry than in emergency times and places encountered during military action. Vapors from certain chemicals have proven to be excellent inhibitors of rust and corrosion. So far, paper has proved to be the most effective vehicle to hold the supply of the inhibitor in proximity to the object to be protected. A vaporproof wrapping is required to prevent dissipation of the inhibiting agent. This type of packaging offers an extended field of development for the paper industry.

Map and chart papers for field use have not only the usual requirements for this type of product, but even greater need for wet strength and dimensional stability.

The above-mentioned problems are only a part of the requirements of paper and paperboards for military use, but do provide a basis for considering extended fields for research. These items developed as emergency measures and substitutes for military use during the past wars have often formed the backbone for extended fields in civilian usage later.

Barrier Materials

We have advanced in the development of better, more economical, and more flexible greaseproof barrier materials since 1943 when Specification AXS 840 was issued. The need for a truly conforming wrap that would contain any known rust inhibitor against the part without itself causing corrosion was well recognized then as it is now. This has become more and more difficult to achieve due to the development of new and more complex greases for use as corrosion inhibitors.

The containment of these new greases, especially some of the more complex synthetic types, by the use of intimate wraps has been most difficult to achieve economically. Some of these materials have a very low viscosity, and they also possess solvent and penetrating properties. To be effective, a film barrier must prevent not only the penetration but the absorption of the grease.

The issuance of the new specification JAN-B-121, Amendment 2, is the result of many years of development and cooperation between industry and the military. Although improved over the old AXS 840 and JAN-B-121, dated 1946, neither the military nor industry consider it to be entirely adequate. JAN-B-121, Amendment 2, is a performance type specification. We believe that we should utilize this type specification for barrier materials. Its benefits are evident and we need not discuss that here.

We are still in the process of changing and tightening these specifications in order to procure more suitable material, but we must always be practical. We must not disallow in the specifications any materials that our American industrial ingenuity can make work in order to broaden our source of supply. To discuss all the ramifications of the manufacture and use of greaseproof barrier materials would take much more time than we now have. We will, therefore, only discuss the important requirements under JAN-B-121.

A good greaseproof barrier material should absorb little if any of the grease, and should be effective against any commercial grease. We must repeat that experience of approximately 10 years has shown that not all of the materials and methods which merely meet the requirements of the specifications result in an item that satisfactorily meets the end use required of a good greaseproof barrier. There are many methods available to make Grade C and Grade A barrier materials conforming to the above specification. We will first discuss Grade C barrier material.

Grade C Barriers

There are two types—heavy duty and medium duty, and also two classes —class 1, free of transferable coating on one side, and class 2, which has a self-adhering coating on both sides. Grade C barrier materials may consist of waxing creped kraft paper alone, or of laminates of paper and acetate or cellophane or other film, of cloth laminated to cellophane or acetate, or of paper which first has been coated with a polymer such as polyethylene and subsequently waxed, and others.

Another method which has recently been introduced is a combination of paper and acetate which is reinforced with glass fiber. All these processes and methods can produce a Grade C barrier material conforming to the specification. One outstanding combination consists of a suitable cotton cloth, a film of either cellophane or an acetate of proper thicknesses, generally one mil., and a good microcrystalline wax of a medium color. This combination gives that peculiar flexibility, moldability, and workability which is most desired for the end use. It is unfortunate that to date there is no available test which will clearly define this property (moldability), although there is a desire to incorporate such a test in the specifications in the very near future. The above combination also minimizes blocking, and facilitates unwinding of the roll when actually being used. Practically, a slight amount of blocking is not objectionable; the material still can be pulled apart, and is usable. Further, this laminate does not depend upon a wax for its grease-resistant properties. It depends upon a film barrier, such as cellophane, or cellulose acetate, which are among the most resistant films known to the type oils and greases presently used by the military. One of the conventional methods for producing this type of barrier material comprises passing a suitable cotton fabric and cellophane, or other suit-

able film, simultaneously through a tank containing molten microcrystalline wax at a controlled temperature, keeping the two webs completely separated up to the point of entering a set of squeeze rolls which are adjusted to allow the proper amount of coating to remain both in between the plies and also on one or both outer sides. Subsequently, these two materials are passed over a series of rolls to solidify the wax. Care must be taken to minimize entrained air which will cause puckering or wrinkling. The sheet is then wound into jumbo rolls and subsequently cut to the proper width and yardage. (Certain manufacturers attempt to chill the barrier material immediately after leaving the squeeze roll by passing it through a bath of cold water.)

Care must always be taken, of course, to secure clean trimmed edges of the rewound material and to maintain close control of its dimensions. The barrier material should be handled very carefully till such time as it is packed in a suitable tubular container. In order to further reduce any possible damage to the ends of the roll some manufacturers use a core ½" longer than the roll. This allows a quarter of an inch extension on either side and has resulted in a better packaging of the barrier material. Some manufacturers put an oil soluble green dye in the wax for identification. Others identify by striping, with striping or roller equipment. Some manufacturers contend that no color should be added to the wax bath, as it may be fugitive or easily rubbed off or smear. Certain colors may be of low solubility and must be dissolved in a blending material such as stearic acid in order to get uniform distribution. During the last war a number of cases of dermatitis were reported and investigation revealed that the color used in the identification of greaseproof barrier material was the cause. In addition, it has been feared that these dyes may accelerate corrosion. In order to be sure that the identification mark complies with the requirements and still definitely eliminates any possibility of dermatitis, many manufacturers are striping on the reverse side of the film so that the side of the barrier material which comes in contact with any part has no artificial coloring. We will not discuss in detail any further description of the specification, or the uses of the end material, as this information can be found in the various Government packaging manuals. We should examine some of the practical problems in the field.

Identification, blocking and moldability have already been discussed. It is important to consider defects which might be aptly described as "latent defects." These are defects which are not readily apparent at the time of acceptance by the Government either by the field inspector or by laboratory tests. It has been noted that much material which might be readily workable in some parts of the country and be highly satisfactory, may be completely unsatisfactory in still other parts of the world. We find various forms of delamination which become apparent only after some time has elapsed after manufacture. It is for this reason that we expect to eliminate the use of certain products by changes in the specification. We have used a more rigid greaseproof test, not only to obtain better grease-resistance, but also to eliminate the use of products which in the past have proven unsatisfactory.

Grade A Barriers

We are constantly attempting to write into the specification requirements that would attempt to eliminate these latent defects. Our most serious problem has been in the procurement or use of the Grade A material under this specification. There are two types of Grade A material. One is the heat sealing grade, which is widely used for bags, the other is an intimate wrap. The intimate wrap was originally developed to prevent the coating of the Grade C greaseproof barrier material from being transferred to the part. Grade A barrier materials are made from the following materials, polyethylene and paper, glassine laminated to kraft paper, acetate and cellophane laminated to kraft paper, cloth laminated to cellophane or acetate plus various types of coating on kraft paper, all of which must result in a grease resistant end product.

In a discussion of this kind we are not free to list the many paper and paperboard products and treatments that have been developed for a particular military use. It so happens that a number of items are converted products. While most of you will recognize, and no doubt have knowledge of how to produce some of these items, nevertheless, this information is marked "restricted" and in some cases "confidential" and "secret."

Military Storage Requirements

As we have stated before, military use calls for a different sort of planning and thinking than we usually apply to civilian use or consumption. "Stock piling" is a term much tossed about and which is subject to a wide interpretation. Our whole economy of distribution and consumption of civilian goods is based on quick turnover and moderate inventories, so that the public may be served with a constant supply of fresh fruits, vegetables, etc., the latest styles of clothing, the latest models of radios, television sets, autos. In fact, this is the basis of good merchandising and profit.

Stock piling for military purposes has the fundamental meaning of immediate supply of the necessary items, in sufficient quantity, in the proper places, for strategic emergency uses. The length of time in stock-piled storage may be indefinite—one, five or ten years; but when the call for material comes, it must be there ready for use.

To meet such stock piling storage conditions, military packages must be treated to prevent insect infestation, to afford repellency to mice and rats, to prevent loss from mildew and fungus growth and other hazards.

Such treatments may not be necessary for all civilian inventories, however, extra cost for these treatments can readily be justified for military use.

Emergency Use Items of Paper

Our military observers in other countries are alerted to report officially on unusual items or practices that differ from our own supply or routine.

Norway and Finland have in use many items, such as paper blankets, paper sleeping bags, paper arm-slings, paper vests, paper bandages, paper disposable sheets, etc., which are economic substitutes due to the shortage and high cost of cotton fabrics and other textile materials in their country.

In Japan, during World War II, paper sandbags were widely used due to lack of cotton and jute.

For emergency use, we understand, the Civil Defense Organization has stockpiled paper blankets, paper cups, paper plates, etc., for use in the event of an atomic bombing.

In Alaska last winter a project was undertaken to design a temporary shelter tent made from paperboard and small strips of wood from packing cases. The "Thing" was reported as far more comfortable at —50° F than the light weight textile tent in regular use. From that effective result we have been requested to study this expendable temporary tent idea at once.

The field is not entirely new since temporary paper paulins reinforced with sisal fibers were developed and used during the "emergency" of the last world war. Since then, glass scrim in various meshes, has found wide application with kraft. This was

then waxed and even Polythene coated.

The Weatherproof Solid Fiber Box

We mentioned the development of the weatherproof paperboard box, used for military containers. The accomplishments of Military Task Groups deserve continuing praise and applause, and should be considered foremost in the milestones of progress in this segment of the paper industry.

If we had time, we should present this entire story without omitting a paragraph. Instead, I have "lifted" short statements to give you the magnitude of this work.

"The box that carries tomato juice from the canning plant to the corner grocery store does a good job of protecting its contents. But to attempt to use it for shipping goods overseas to the fighting fronts in wartime would be like using eggshell china to make a soldier's mess kit.

"At the beginning of the war, the fibre box industry had made only modest progress toward developing a truly weatherproof container. It had developed and produced commercially a box designed for use as a returnable beer case which was satisfactory for that job. This was the type of box that first came into widespread use for Lend-Lease shipments before Pearl Harbor.

The First Weatherproof Box

Repeated tests showed that to produce a box which would retain its strength after exposure to water it was necessary to work on every part of the box: the component plies of paperboard, the adhesives used to combine the plies, and the glue used to seal the box. To make the job even more difficult, all this had to be done so far as possible with existing board-making and laminating equipment, because there was neither time to re-equip the industry nor priorities available to insure equipment deliveries. Also, the box to be developed and the glue for closing it had to be usable on the packer's existing equipment, which was set up for the domestic-type box. Finally, it was necessary to allow for the scarcity of critical materials and to keep within reasonable bounds on costs.

The First Vs Boxes

Because the Guadalcanal operation had brought home forcibly the need for boxes which would preserve their wet strength after prolonged exposure to surf and salt water, the industry was asked to increase the wet strength standard of the boxboard from 2½ to 24 hours. To meet the new requirements, much more sizing had to be added to all the plies of paperboard and the plies had to be laminated with new adhesives developed for the purpose.

These first "24-hour" boxes were made of all-kraft board, at great expense and with very great consumption of scarce kraft pulp. Because their performance characteristics were so revolutionary, new techniques of testing had to be developed. Their dry strength was so great that the conventional tests for retention of contents when dry were abandoned, and tests were made only after they had been immersed in water for 24 hours. So durable were they after 24 hours of soaking in the surf that, in the first two series of Government tests, drop tests were made with the soaked boxes from a height of 12 feet onto a concrete floor.

The performance of these new boxes was first demonstrated to representatives of the Government procuring agencies and the War Production Board in November, 1942, at Georgetown, S. C. Various sizes of boxes were used to determine the effect of varying dimensions and weights of contents. The 12-A box and wooden boxes were also subjected to the tests at the same time.

The tests proved conclusively that a weatherprooof solid fibre box could be built equal to any other type of container which had been developed up to that time. These first boxes, made of paperboard not quite one-tenth of an inch thick, had an average dry bursting strength of 884 pounds and an average wet strength, after 24 hours soaking in the surf, of 468 pounds. In a series of severe dropping tests they retained and protected their contents better than any competitive type of container.

Meanwhile, experiments were being conducted with boxes made from waste materials (jute). They resulted in the development of a board made almost entirely from wastepaper, chiefly kraft, which had a dry strength of 750 pounds and a wet strength of 500 pounds. Such boxes evidenced no ply separation after 24 hours immersion in the surf off the Rhode Island shore. After the loaded boxes were removed from the ocean, they were dropped over 50 times from a 30-inch height onto a concrete floor before they split open. An enthusiastic demand for the new boxes developed immediately from Government procurement personnel.

It was clear from the beginning that both the all-kraft and the jute box were stronger than necessary for the shipment of many items. It was found, for example, that when the boxes were packed with canned goods, their strength was far in excess of the strength of their contents. And the great amount of new kraft paperboard being used, particularly in the all-kraft box, was to be deplored at a time when paper supplies were becoming critically short.

Box manufacturers had discovered by this time that they could "tailor-make" boxes from both kraft and jute board to fit other less rigid specifications. Accordingly, three grades of boxes were proposed for new specifications then being discussed by representatives of the procurement agencies, the War Production Board and the solid fibre box manufacturers. Army acceptance of these new boxes was announced by issuance of Specification OQMG 93 in December, 1942.

Developing Waterproofness

Domestic fibre boxes are only reasonably resistant to moisture penetration, and it had been found that dipping, spraying, or other surface coatings did not materially increase that resistance—particularly if the box was to be subject to any scuffing.

As far back as 1931 several box makers were experimenting with the use of asphalt, just below the outer surfaces of the containerboard, to protect the inner plies of board from moisture penetration. By the use of this barrier, or "raincoat", it was possible to manufacture a board that would have the high wet strength required but made with inner plies which, although heavily sized, contained a much lower percentage of kraft pulp than was formerly the case. This development had the effect of bringing additional board mills into the Vs box picture.

Asphalt was demonstrated to be the most practical material for the waterproof barrier, which was provided by using asphalt duplexed liners for both the inner and outer plies of the V-board. These were made mandatory in cases for canned goods and were employed in the greater portion of the V1s and V2s boxes produced.

Finding the Right Adhesives

Along with the introduction of more highly sized board and of asphalt moisture barriers, the box makers were hunting for adhesives which could be used on conventional laminating equipment and which would provide highly water-resistant glue lines.

In the early work with the returnable beer case and bomb fin box, it had been found that starch adhesives were more water resistant than silicate. The idea of adding urea-formaldehyde came from the work being done

with plywood by the Forest Products Laboratory. By the middle of 1942, most manufacturers of adhesives were experimenting with a starch-urea-formaldhhyde combination, and the performance of the first Vs boxes showed that this adhesive possessed all the desired properties. An additional advantage was that its cost could be reduced if it were extended by addition of clay or asphalt emulsions.

The new adhesives were tricky to work with, having in the beginning a very short pot life. By adding ammonium chloride as a catalyst, it was found possible to lengthen the pot life and also to hasten the cure of the adhesive. Other satisfactory adhesives have since been developed, but most of them are higher in cost than starch-urea-formaldehyde, which is the most commonly used.

Setting Up, Sealing, and Shipping the Vs Box

The glues used before the war for sealing were, like the adhesives used to combine the plies, satisfactory for domestic shipments but not suitable for the weatherproof box. A new glue had to be developed which provided as good a bond for the flaps as the improved adhesives did for the side walls and a glue, moreover which would not only work well on the packer's case-sealing equipment, but would also be adaptable to hand brushing. Otherwise there would be delays in sealing at the user's plant. Furthermore, it had to be usable in temperatures ranging from the frozen storage warehouse to the hot, humid conditions of the cannery.

Glues which met these specifications were developed, in the same manner as the sidewall adhesives, by cooperation of the Weatherproof Solid Fibre Box Group with the glue manufacturers among themselves.

New Type of Weatherproof Boxes

To reduce the drain on the pulp supply, it was found desirable to introduce boxes with less rigid specifications for shipments within the United States. A high degree of waterproofing was needed, but nothing like the strength of the Vs boxes. Three new solid fibre boxes were developed, originally christened the V-4, V-5, and V-6, but renamed with the W-symbol in order to prevent confusion with export boxes. It was thus possible to issue instructions that only V boxes were to be used for overseas shipment. (Actually, many of the W5s boxes were later shipped overseas.)

The provision of various grades of boxes for packages which did not need the tremendous strength of the V1s box greatly reduced the strain on the kraft supply, shifting the burden to waste paper. Whereas the V1s box required the use of some 380 pounds of kraft for a thousand square feet of board, the V2s took about 300 pounds, the V3s 100 pounds, and the W5s only 40 pounds.

A Satisfied Customer Speaks for Himself

"All the critics inside the Marine Corps and other branches of the armed forces soon found the paper boxes were doing a very splendid job. They could stand rough handling, especially dropping, even better than wood boxes. They are much lighter, less expensive, occupy less cubic space, and could be obtained in the quantities desired, and they were easily stored, as they could be shipped flat."

Extract from U.S. Marine Corps Publication "Paper Boxes Go to War with the U.S. Marines."

Fibre Boxes Stood the Gaff

"With the success of an entire campaign frequently hinging on the safe delivery of supplies in safe condition, too much emphasis cannot be placed upon the packaging research to which your organization contributed so much."

"War shipment recognizes no such cautions as "handle with care," "fragile", "use no hooks". The speed and conditions under which many items in the weatherproof fibre boxes had to be unloaded (often under actual fire) frequently resulted in the toughest sort of handling, yet they proved they could take it."

R. A. Hickman, Assistant Chief Packaging Branch, Ordnance Dept.

A Big Job Done—A Big Problem Licked

"More than 814 million weatherproof solid fibre boxes have been manufactured since the Vs box was first announced in December 1942. Just over half of them (51 percent) were V2s boxes, and almost a third (32 percent) were V3s, while the V1s accounted for 11 percent and the W5s for the remaining 6 percent (the W4s, although accepted in the specifications, was not produced commercially.) The high point of production was in May, 1945—the month of V-E Day—when the industry turned out 44,484,000 Vs boxes, which was equal to 25 percent of the total tonnage of all types of fibre boxes produced in the United States in that month.

"As might be expected, the more rugged V1s box was first specified for a very large proportion of the products shipped overseas, and in the first year of production of Vs boxes, the V1s, V2s and V3s were produced in almost equal quantities."

Subsistence Packaging

If you are interested in military packaging, I recommend that you obtain and read the following reference.

Volume Five of Operations Studies Number One, Quartermaster Food and Container Institute, dated September 1945, covers in a most complete manner the packaging and packing of subsistence (food) items used by the Armed Forces up to that time. This edition is completely out of print and many of the findings and conclusions are out of date, since better materials, methods and processes are in effect at present. This volume can be considered as a historical record, irreplaceable and for reference purposes only. It tells the story of the work accomplished on subsistence packaging during those strenuous years.

Solid Fiber Boxes

The story of the Weatherproof Solid Fiber Box, its wartime accomplishments and its application to peacetime commerce and industry is concisely told in this small volume. Your file on military papers would be woefully lacking without a copy.

Specifications

I want to refer your attention for particular information on paper to the list of Federal, Joint Army and Navy (shortened to JAN) and Military Specifications. These specifications are standard references for details of tests (chemical, physical and functional) and sometimes for specific details of manufacture. However, constant revisions are occurring or amendments added to clarify or improve the product. No product or item is static, but is subject to the continuing adoption of new materials that are acceptable and show definite improvement. Due to this continuing change in specifications, it is necessary to obtain the one with the latest dating.

Another task group undertook the development of standards for flexible case lining materials for military packaging. This work has been recorded in a small pamphlet entitled, "National Bureau of Standards Miscellaneous Publication M-182" and issued 23rd. of September 1946. From this data we still have in effect today two Specifications, JAN-P-125 and Federal Specification UU-P-271, and another revision is being considered to incorporate newer developments of laminated papers.

Specialty Impregnation

Ralph T. Nazzaro

Westfield River Paper Co.

I suppose the word "specialty" has reference to unusual or highly specialized forms of treatment of fibrous cellulosic materials, but I like to feel thot these treatments are called "specialty" largely because the treatments and technology are comparatively new and because the finished products from specialty impregnations are still finding new entries into established as well as unexplored fields.

For the sake of simplicity let us ask ourselves four questions about specialty impregnation and attempt to present this lecture by finding an answer to each of these four conditions, namely,

1. What is manufactured by specialty impregnation?
2. How are these products made?
3. What are the limitations and successes of the products so manufactured?
4. What of the future?

What is manufactured?

Many varied and useful products are manufactured by one of several modifications of impregnation methods and among these are the following: a) artificial leathers; b) shoe parts (innersoles, midsoles, quarterling, socklinings and reinforcements, e.g. shoe tapes); c) wrapping papers and protective coverings; d) goggle case coverings; e) gaskets; f) oil filters; g) paper base tapes; h) battery separators; i) paper base plastics (e.g. wallboard, paper laminates for structural, electrical or decorative purposes); and j) asphalt—oil and waxed papers—related to this discussion, but generally a well established and considered a separate field.

The chief purpose of treating cellulose fiber by one or more of the well known processes utilizing some combination of rubber, resin and plasticizer is to improve and alter substantially mechanical, chemical and functional properties of the cellulose sheet. The extent of change is dependent upon: the amount of material actually deposited on the fibers or left in the sheet; chemical nature of the resin, plasticizer or rubber; and manner of producing the treated sheet i.e. via beater addition, wet web saturations or dry saturation. In other words, whenever we describe a given product in terms of its physical properties we should at all times qualify the description in terms of concentration, type of resin, and method of manufacture.

Generally all the physical properties are improved and at the same time we can expect improvement against greases, oils, solvents, acids, alkalis, and the like.

Figures I, II and III will illustrate some of the more improtant mechanical changes which are obtained by treating a kraft base paper of saturating quality with a GR-S rubber saturant, type IV. The paper base had an original basis weight of 130 lb. (25x40-500); thickness of 0.022"; tear factor of 0.77 and a burst factor equal to 0.085.

The classes of materials used in the impregnation of paper or suspended fiber can be divided into chemical groups as indicated under Table I.

From the list it is apparent that we should obtain two very distinct types of end products depending upon the nature of the treatment, namely, one class, the thermoplastics, of relatively soft, flexible products and the second, thermosetting, of comparatively brittle, but strong and firm materials. This leads us to a discussion of the second question.

Ralph Thomas Nazzaro received his Bachelor of Science degree from Boston University—1936, PhD. in Organic Chemistry from Clark University—1948. He was Research Chemist for General Latex and Chemical Corp., from 1936 to 1941; Director of Laboratories, American Resinous Chemicals Corp., from 1941 to 1943; attended Mellon Institute between 1943 and 1945 on Premoid Products fellowship; Technical Director of Premoid Products 1945 to 1949; Associate Professor of Forest Chemistry at the College of Forestry, Syracuse, N. Y. from 1949 to 1951 and Technical Director of Westfield River Paper Co., 1951 to present. He is a member of the Society of the Sigma Xi; member of TAPPI and chairman of the TAPPI Plastics Committee; fellow of American Institute of Chemists and member of the American Chemical Society.

How Do We Make These Products?

To answer this question we must know something of the chemistry of the treating substances. I believe that the technology of paper making is better known from a practical view than the handling of these colloidal solutions under the most satisfactory paper making techniques and the limitations due to paper making machinery.

Nature of the Resins for Treating Paper Making Fibers

Broadly, we have two classes of materials: the thermoplastics and the thermosetting.

The thermoplastics can be further classified as derivatives of the vinyl group ($-CH_2 - CH-$) and the substituent group determines the contributory nature of the resin.

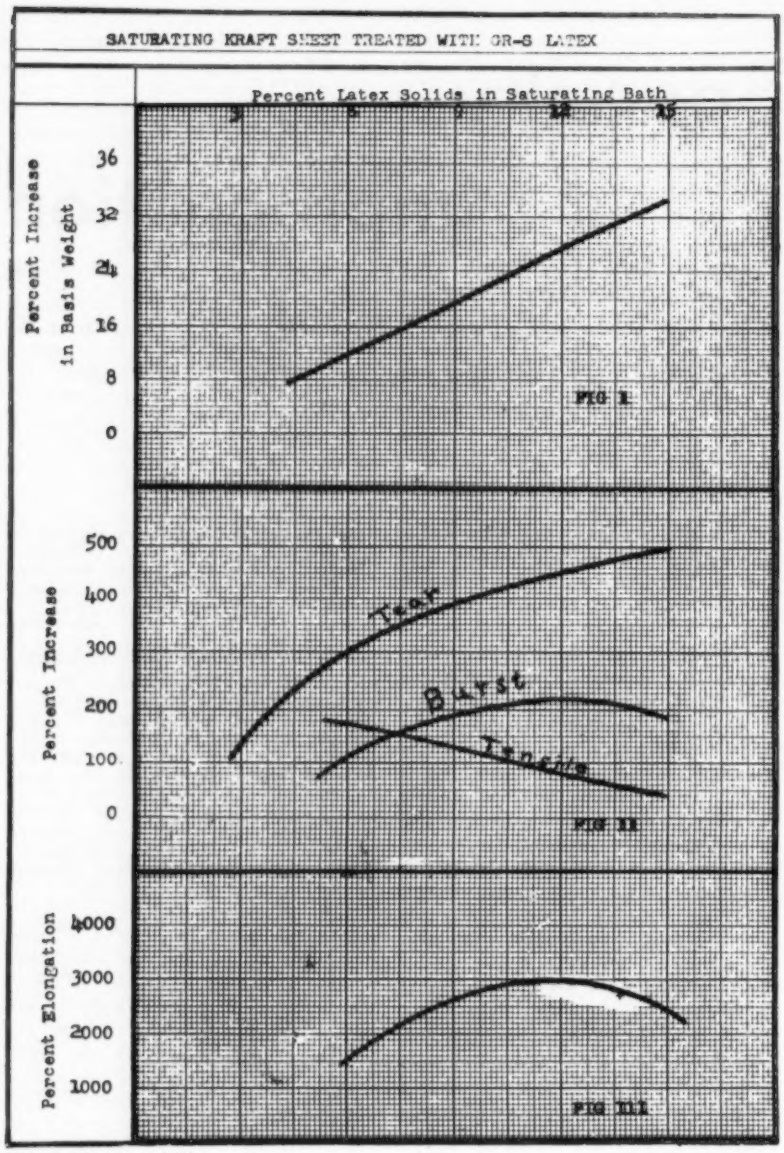
If the substituent group comprises a highly polar group such as halide, hydroxyl, carboxyl, ethoxy, methoxy, etc., the fiber treatment will yield a highly brittle, thermoplastic sheet of relatively high tensile, poor fold endurance, but of improved chemical resistance, corresponding somewhat to the nature of the resin. The extent of these changes will depend, naturally, on the concentration of the resin on the fibre. I have previously stated in TAPPI

that prominent electronegative groups such as these will yield polymers which in themselves are stiff because of their high intermolecular cohesion. As the resin dries from its aqueous system, a random network of resin particles will form around the fibres of the paper in more or less of a discontinuous film. If the intermolecular forces of the resin particles exceed the adhesive forces of the resin for the cellulose or at least if these forces are in excess, the resulting resin-paper sheet will show poor bonding and the resin can be removed rather easily by washing or even by mechanical means under some special instances.

The adhesion can be improved substantially by mixing compatible plasticizers with the resin which apparently tend to diminish intermolecular forces within the resin and improve adhesion to paper fibers as well as increase the flexible nature of the end product.

Each resin has its own particular system which determines the compatibility of the resin for solvent plasticizers. The full appreciation of this fact can best be followed by the work of R. F. Boyer, J. Appl. Physics, *20*, 540-552 (1949) where Mr. Boyer establishes the basis for polymer-plasticizer interaction constants as a predictable index of compatibility, efficiency, and permanence. Briefly, Boyer and Spencer, J. Polymer Science *2*, 157 (1947) succeeded in showing that each polymer system has its own value of compatibility, efficiency and permanency dependent upon experimental constants and that even a given plasticizer has its special limits of compatibility for a given resin system. These points must be well taken whenever we are faced with the development of a resin composition for any paper treatments and we must also bear in mind that in addition the cellulose fibers themselves may compete for plasticizer molecules which will definitely complicate our problem as technical men in the paper industry.

The rubbers, on the other hand, are intrinsically more flexible since their molecules have reduced intermolecular cohesion and by difference show better adhesion to paper fibers. For reasons indicated, polychloroprene will yield sheets or boards with higher tensile strength and better burst than paper fibers treated with an equal amount of GR-S or Buna N, but both of the latter polymers will yield better tear resistance and fold endurance than neoprene treated fiber. The difference may be small at low concentrations ofpolymer to fiber, but nevertheless significant.



Figures I, II and III

TABLE I

The classes of materials used can be divided into chemical groups as follows:

1. Vinyl Polymers—emulsions or dispersions: polyvinyl acetate; polyvinyl chloride; copolymers of vinyl chloride—acetate; polyvinyl aldehydes—formals, acetals, butyrals; polystyrene and polydichlorostyrene; acrylic and methacrylic esters; polyvinylidene chloride and copolymers; allyl compounds; polyvinyl ethers; polystyrene and copolymers with dienes; and polyacrylonitrile and copolymers.
2. Cellulose Derivatives—emulsions: cellulose nitrate; cellulose acetate; cellulose aceto-butyrate; cellulose aceto-proprionate; and cellulose ethers—methocel and ethocel, carboxymethyl cellulose (CMC), hydroxyethyl cellulose (cellosize), benzyl cellulose.
3. Polyesters—emulsions: unmodified; oil modified; and unsaturated debasic acid alkyds copolymerized with vinyl or allyl monomers.
4. Polyamides—emulsions and dispersions: nylons.
5. Amine and phenolic resins—solutions and colloids: alkyd modified urea or melamine formaldehyde resins; phenol-formaldehyde; and urea-formaldehyde.
6. Silicones—dispersions: unmodified polymers; and modified allyl or vinyl copolymers.
7. Terpene and Pinene resins—emulsions: hydrogenated rosin and rosin esters; and polymers of alpha and beta pinene (piccolytes).
8. Rubber Derivatives—dispersions: cyclized rubber; and chlorinated rubber.
9. Synthetic Rubbers—Latices: Buta—S (GR-S); Buta—N (GR-A); polychloroprene (neoprene, GR-M); and isobutene-diolefins polymers (butyl, GR-I).
10. Natural Products—latices, solutions and dispersions: hevea rubber; casein; corn protein, zein; shellac; starch; soy protein; and animal glue.

Table II illustrates the types of bonds involved in resin or rubber modified paper fiber.

All types of bonds indicated play an important part in resin-fiber systems and the differences noted above are due to comparative effects of these electronic forces. Plasticized resins should show more bonds of types two and three than unplasticized resins and more so than rubber-fiber systems. The differences developed in rubber systems can also be described in terms of Table II.

TABLE II

Type of bond:

Mechanical obstructions—shear

Polar bonds—act in shear as well as in tensile (between pos. and neg.). Distance between—4 to 5 A° and force to break is 2-4000 cal/mole.

H-bond—Another type of polar bond. Requires an approach of 2.5-3 A° and 5-8000 cal/mole to break.

Covalent bonds. Must be 1.5-2 A° to establish. Force to break is 50,000 cal.

The specificness of resin plasticized systems can best be compared by reviewing *Tables III, IV, V, VI and VII* respectively, for plasticizing efficiency and retention on polyvinyl acetate-plasticized saturated paper sheets.

From an examination of these tables, it can be easily seen that certain plasticizers are more efficient than others, while still others appear to maintain plasticizer efficiency over a longer period of ageing. It has been recognized that there are three very practical aspects of plasticizer behavior, namely, compatibility, efficiency and permanency and obviously these three important factors must in some way be interrelated. Boyer was able to report on these three problems and develop in detail the performance of plasticizer-resin systems by means of the Flory-Huggins theory of the thermodynamics of polymer solutions.

If we consider Huggins' view to explain deviations in the reduced pressure of polymer-solvent systems by means of a constant μ as in the equation:

$$\frac{P}{c_2} = \frac{RT}{M_2} + \frac{RTd_1}{M_1 d_2^2}(0.5 - \mu)\, c_2$$

then we can be convinced that the slope of line of $\frac{P}{c_2}$ vs c_2 for any number of various plasticizer-resin systems can be given as the value of the constant μ—a factor dependent upon the nature of the solute or c_2. The other terms in the equation are the usual common letters such as M for molecular weight; d for density; R for gas constant and T represents the absolute temperature. Huggins derived the equation to explain deviations in the vapor pressure of polymer-solvent systems and further, considering plasticizers as solvents for the resins, it was reported that phase separation or incompatibility will occur as soon as μ exceeds a certain critical value. It was indicated, for example, that 0.5 is the critical value for a polymer of infinite molecular weight. In other words whenever the plasticizer-resin system has a μ value of 0.55 or greater, then it can well indicate an area of incompatibility between a given plasticizer and a given resin. Knowledge such as this would be invaluable to applied scientists and technicians since it would enable a better selection of plasticizers for the work on hand and also assist in the interpretations of resin-plasticizer combinations used in one or more paper treatments.

TABLE III

Plasticizers

Name	Mol. Wgt.	Boiling Point at 760 mm. °C.	Boiling Point at 4 mm. °C.	Solubility in Water % by Wgt./°C.	Evoporation g/sq. cm. 100 hr. at 100°C.
Dibutyl Phthalate	278	330-340	160-170	0.04 /25	0.000221
Diamyl Phthalate	306	336-340	170-175	0.03 /25	0.000217
Dibutyl Sebacate	314	344-345	194	0.1 /25	.....
Dicapryl Phthalate	362	360-370	229	0.03 /25	.....
Dicarbitol Phthalate	398	340-350	220-255	1.00 /20	0.005
Dioctyl Phthalate	390	.....	216	0.04 /20	.....
Flexol 3GO	403	.....	212	0.01 /20	.....
Flexol 3GH	347	358	.....	0.02 /20	.....
Kronisol	366	344-355	212-232	0.1 /25	0.001
KP-120	398	280 decomp.	220-245	0.004 /25	.....
Tricresyl Phosphate	368	360-370	220-225	0.002 /85	0.00000708
Santicizer B-16	336	310	180-185	0.0012/30	0.0000881
Santicizer E-15	280	280-286	175	0.0175/30	0.0001106
Santicizer M-17	266	275	164-170	0.09 /30	0.000221
Santicizer 8	199	.....	.....	0.213 /48	.....
HB-40	...	393-421	.....	insol (?)	.....
C-24	...	.....	215/5 mm.	0.1 /25	.....
C-35	...	.....	224	0.0073/25	.....
Tributyl Citrate	360	.....	233/22 mm.	0.002 /25	.....
Plastoflex 50	..... composition not disclosed				

TABLE IV

Measurement of the Tensile Strength of Grade 150 Paper 0.040" Saturated Amthor Universal Tensile Strength Tester

Name of Plasticizer Used	Source	T. S. Grams/1" width
Raw Stock—untreated	24 x 36 (500)—96#	470
#35—Dimethylamide of Synthetic Fatty Acid	Resinous Products	6400
Dibutyl Phthalate	U. S. I.	7000
3GH Triethylene Glocol Di-2-ethylbutyrate	Carbide & Carbon	7150
3GO Triethylene Glycol Di-2-ethylhexcate	Carbide & Carbon	7400
Tributyl Citrate	Chas. Pfizer and Co.	7750
B-16 Butyl phthalyl butyl glycollate	Monsanto	8250
Diamyl Phthalate	U. S. I.	8300
Kronisol—Dibutoxy ethyl phthalate	Ohio-Apex	8300
KP-120—Methyl Cellosolve Acetyl Ricinoleate	Ohio-Apex	9050
M-17—Methyl phthalyl ethyl glycollate	Monsanto	9250
Tricresyl Phosphate	Monsanto	9400
Plastoflex 50	Advance Solvents	9600
PD-16	Baker Castor Oil	9550
Dibutyl Sebacate	Resinous Products	9900
Dioctyl Phthalate	Carbide & Carbon	10050
HB-40	Monsanto	10150
KP-140—Tributoxyethyl phosphate	Ohio-Apex	10200
Dicapryl Phthalate	Resinous Products	10700
C-24	Resinous Products	10750
P-6	Baker Castor Oil	10800
Dicarbitol Phthalate	Ohio-Apex	11050
E-15 Ethyl phthalyl ethyl glycollate	Monsanto	11050
Santicizer 8 Ortho and para toluene ethyl sulforamides	Monsanto	12470
Nevillac 10°	Neville Company	14900

Note: 40% Plasticizer on Resin, Dry Basis.
15% Plasticized Resin on Fibre, Dry Basis.

Figure IV illustrates the activity of plasticizer in polymer as a function of composition for several values of the thermodynamic polymer-solvent interaction constant, μ. A value of $\mu = -0.5$ is characteristic of very strong bonding between polymer and plasticizer while 0.5 would be borderline and a $\mu = 1$ would indicate a plasticizer of limited compatibility and possibly one of incompatibility.

Boyer and Spencer demonstrated further an empirical relationship between plasticizer efficiency and the constant, μ. Efficiency was measured by the ability of a particular plasticizer to alter and reduce the brittle point, $\triangle T_b$, of a resin film. *Figure V* bears this relationship according to Boyer and Spencer.

Permanency is the third component of our plasticizer-resin problem and again, it is reported that the rate of loss of plasticizer is governed by the effective vapor pressure or activity of the resin-plasticizer system; by internal diffusion of plasticizer or by both mechanisms operating simultaneously with one or the other dominant. The same considerations which lead us to conclude that chemical composition of the plasticizer molecule determines its thermodynamic interaction constant, μ, can also express diffusion characteristics of polymer-plasticizer systems. Paradoxically, it is found that the most efficient plasticizers are also the same types which can diffuse most rapidly because of their greater mobility or movement within the polymer system. However, a substantial amount of the plasticizer must be firmly held by active polymer groups along the chain as indicated by the practical use of highly efficient plasticizers for both low temperature flexibility and lack of brittleness upon ageing.

The theoretical views on polymer-plasticizer combinations are indeed broad and in fact, the above account is limited only to an elementary discussion of solvent or monomeric plasticizers. The above presentation on some of the theory was given to impress our practical technical people in the paper field that the unusual performance found for some resin-fibre treatments can many times be explained by an examination of fundamental studies.

By contrast, studies with thermosetting resins such as the ureas and the phenolics reveal excellent retention and adhesion from aqueous solutions. Polar bonding and possibly even covalent bonding are prominent through the reactive methylol groups available in the water soluble or water dispersible stages of the resin.

The mechanical properties of phenolic resin additions to southern kraft

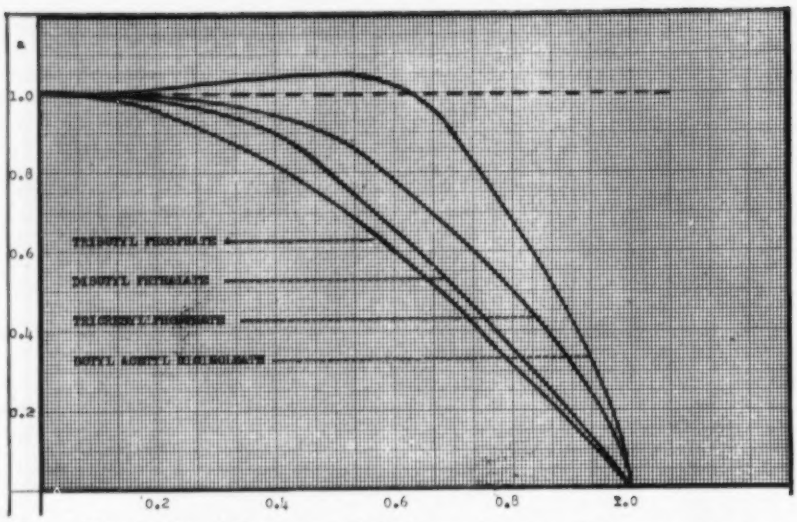


Figure IV—Activity of Plasticizer in Polymer as a function of Interaction Constant Reference: R. F. Boyer, J. Applied Physics, 20, 540-552 (1949).

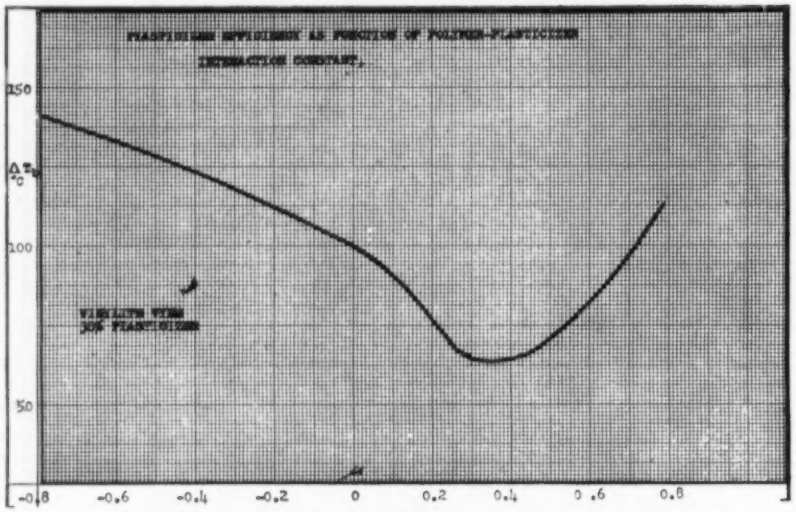


Figure V—Correlation of Plasticizer Efficiency with Constant. Reference: R. F. Boyler, J. Applied Physics, 20 540-552 (1949).

slurries were evaluated by Marander and Nazzaro, "Studies on Beater Addition of Phenol — Formaldehyde Resins", State University of New York, College of Forestry Thesis, June (1951). Handsheets for laminating stock were prepared according to TAPPI standards on a British Standard type sheet mold containing in each case 2.8 grams of pulp at 250 freeness and various amounts of resin varying the basis weight from 90 to 260 pounds (25x40-500). The sheets were dried to contsant moisture content (5-6%) at 70°F and 50% R. H. prior to lamination.

Laminates were made from equal number of sheets at 320° F and 320 p.s.i. and evaluated for strength and moisture resistance as illustrated in *Tables VIII and IX*. Table X gives an interesting account of the absorptive force of cellulose fibres for phenolic resins. The correlation of data between the two extraction methods is indeed striking and convincing.

Manufacturing Methods

In every respect the processing of resin or rubber-fiber systems follows classical colloidal chemical principles.

We have three general methods of manufacturing treated papers of the type described, namely—

1. Beater, stock chest or headbox addition
2. Wet web saturation

3. Size tub or off-machine dry saturation

Regardless of the method employed and irrespective of the advantages of one method over another, the problem facing the paper technologist is the same fundamentally. There are problems of colloidal stability to electrolytes and mechanical agitation, problems of colloidal dispersion and compatibility, colloidal retention and distribution or the resin phase, finally colloidal precipitation and formation. If the paper technologist were to consider his every day projects on pulp preparation and web formation in terms of colloid chemistry, these problems on the colloidal behavior of resinous solutions and latices would be easily understood by comparison. However, the idea of adding latices or resinous solutions and dispersion to pulp slurries usually causes an unnecessary degree of fear and skepticism.

Resinous systems, whether suspended as a latex or in solution, behave strictly as colloids. I don't think that there is any question tbout the electrokinetic behavior of pulp slurries and that the suspended particles are subject to ionic absorption. The same conditions apply to suspended or solvated resinous systems except that the boundaries of the so-called critical zeta potential are greater and hence resinous systems in most cases appear to be more sensitive to ionic concentrations and will destabilize prematurely. Such advanced coagulation will foul up paper machinery all along the way without exception and will generally terminate a project before it had the chance of getting started.

Any method selected for manufacture must of necessity provide for formulation of either the pulp or the latex so that first, their colloidal response will be similar or in another manner, alter the ionic atmosphere of either the pulp or the latex so that the end-product resulting from combination of the resin particle with the fibre is a new colloidal particle distinct and different from either the original latex particle or suspended fibre. In either way, retention will be better and little or no free resin will be left in the white water.

Two of the well known methods of beater treatments—the duPont Process for Neoprene addition and the American Cyanamid's Bardac process follow these general conditions:

The Bardac process operates by adding a melamine-formaldehyde acid colloid to susupended fiber (at least 2 per cent on dry fiber) and it is reported that the ionic surface of the pulp fiber assumes a positive electrostatic charge by adsorption of the positive acid resin colloid. Under these circumstances the electropositive pulp would adsorb large quantities of anionic latex or resin dispersions, such as GR-S, Hycar, polystyrene, polyalkylacrylates, etc. The theory seems to be that the attached acid colloid precipitates or deactivates the small amount of emulsifying agent stabilizing the latex so that a large quantity of latex can subsequently be deposited upon the large surface area of the pulp fibres. This view appears to be the published mechanism of the Bardac process, although it is my opinion that a part of the deposition of the latex particle at least is due to direct adsorbtion of the negatively charged anionic latex particle.

A general procedure for incorporating GR-S to kraft paper is described by American Cyanamid circulars on this subject and also by my former

TABLE V

Per Cent Change in Stiffness Based on Averages

(From zero through 168 hours at 78° C.)

	0-24 Hrs.	0-72 Hrs.	0-120 Hrs.	0-168 Hrs.
Kronisol	+36.5%	+61.0%	+65.0%	+65.0%
3 GO	+18.0%	+55.0%	+76.0%	+120.0%
KP-140	—3.6%	—2.6%	+48.0%	+60.0%
B-16	+13.0%	+34.0%	+115.0%	+135.0%
Tricresyl phosphate	+12.5%	+18.0%	+94.0%	+94.0%
Dicarbitol Phthalate	+10.0%	+17.0%	+46.0%	+72.0%
Tributyl citrate	+19.5%	+38.0%	+115.0%	+150.0%
KP-120	—12.0%	+8.5%	+140.0%	+200.0%
E-15	+18.0%	+65.0%	+245.0%	+360.0%
3 GH	+37.0%	+110.0%	+305.0%	+475.0%
Dibutyl sebacate	+27.0%	+35.0%	+195.0%	+250.0%
PD-16	—37.0%	—41.0%	+13.5%	+36.0%
M-17	+34.0%	+68.0%	+230.0%	+390.0%
Dioctyl phthalate	—31.0%	—6.5%	+90.0%	+98.0%
SR-13	+32.5%	+77.0%	+240.0%	+340.0%
Dicapryl phthalate	—17.0%	—16.0%	+80.0%	+81.0%
P-6	+47.0%	+47.0%	+155.0%	+185.0%
Plast. 35	+2.0%	+11.0%	+85.0%	+155.0%
C-24	+6.0%	+5.5%	+31.0%	+50.0%
HB-40	—3.0%	+6.0%	+120.0%	+195.0%
Dibutyl phthalate	+63.0%	+190.0%	+580.0%	+770.0%
Diamyl phthalate	+48.0%	+180.0%	+540.0%	+940.0%
Nevillac 10*	+24.0%	+27.0%	+170.0%	+230.0%
Plastoflex-50	+62.0%	+244.0%	+630.0%	+890.0%
Santicizer 8	+94.0%	+115.0%	+390.0%	+810.0%

Note: 40% Plasticizer on Resin, Dry Basis.
15% Plasticized Resin on Fibre, Dry Basis.

TABLE VI

Properties of Paper-resin Combinations—Beater Addition

	Untreated	Buna N	Polyvinyl chloride	Plasticized polyvinyl chloride[a]	Polyvinylidene chloride	Plasticized polyvinylidene chloride[b]
Bursting Strength, psi	105	129	157	149	159	130
Burst Factor	0.486	0.520	0.633	0.575	0.650	0.506
Tensile Strength, kg	13.07	11.83	19.10	17.38	24.01	15.03
Elongation, %	4.5	7.5	6.4	7.0	5.8	6.3
Tear Strength, g	566	589	544	576	482	538
Tear Factor	2.62	2.37	2.19	2.22	1.94	2.09
Stiffness, g	7.1	6.3	8.2	8.4	9.0	7.8
Porosity, sec	63.8	34.6	37.6	37.4	100.6	36.8
Valley Size, sec	0.5	2.8	6376.6	9.6	275.6	5.7
Bulk, mils	20	22	22	22	21	23
Bulking Factor	1.67	1.60	1.60	1.53	1.53	1.62
Basis wt. lb—25x40-500	216	248	248	259	248	257
Resin Added to Beater, %	———	13.0	13.0	13.0	13.0	13.0
Resin Retention, %	———	45.9	64.1	———	43.2	———
Resin in Sheet, %	———	5.99	8.35	———	5.64	———
Freeness with Resin, ml	———	376	263	276	234	247
Drainage Time, sec	62.1	40.0	89.5	112.7	87.1	111.0
Heat-curing Time, min	———	1	5	3	3	1
Heat-curing Temperature, °C.	———	130	150	150	150	150

[a] Contains 25% Santicizer B-16 as plasticizer.

[b] Contains 20% dibutyl phthalate as plasticizer. Plasticizer is not included in calculation of resin added.

Reference

Oliver, A. W. and O'Neil, P. W., Technical Association Papers, *30*, 426 (1957).

associate, James P. Casey in "Pulp and Paper", Interscience Publishers, 1952.

The duPont process follows the colloidal idea of preconditioning the latex particle prior to pulp addition so that the systems of fiber and resin will respond more uniformly to alum or acid precipitation without premature coagulation of the neoprene latex. In the original work it was stated that in order to obtain satisfactory results, it was necessary, to presensitize the latex by dilution and dilute alum solution. In subsequent work duPont chemists pre-conditioned the fiber slurry to pH of 8.5, diluted their alum and latex to 5 per cent concentration and added the latex followed by alum in quick succession according to their "Continuous" method.

Either method resulted in hand sheets and mill trial sheets of unusual wet strength, flexible, with improved fold endurance, internal tear and tensile as well as chemical resistance.

The remaining two methods of manufacture shall be treated together since the problems of handling are quite similar with minor exceptions mostly from the concentrations of saturants employed. The wet web saturation method (Novak process) usually uses a higher solids saturant than the dry saturation method or tub size application procedure.

The major problems in saturation stem from mechanical instability and migration of the resin or rubber into decided two sidedness. Both conditions, however, have been amply satisfied: the first, by compounding the aqueous systems with protective colloids such as ammoniated casein, starch, gelatin, etc. and non-ionic or electrolyte stable surface active agents, and the second of these situations was solved by presensitizing the latex. Pre-sensitizing involves the addition of a compatible chemical compound in solution to the stablized latex and one which will cause destabilization of the latex either in time or at some elevated temperature. In other words, these chemicals are delayed coagulants. For example, zinc chloride solutions are active precipitants for anionic colloids, but zinc-ammonia chloride complexes in solution can be added to a stabilized latex. When such a latex is heated the loss of ammonia will shift the equilibrium to the formation of coagulating zinc ions. Other types of delayed coagulants used are sodium silicofluoride, zinc ammonia hydroxide, $MgSO_4$ (ammoniated), ammonium sulphate (with excess NH_3) and the nitroparaffins (in the presence of zinc salts).

The dry web, semi-dry web or wet web can be saturated with a heat-sensitized latex and after doctoring off the excess by normal squeeze rolls, the saturated sheet is dried over the usual paper cylinders at such an elevated temperature that the resin or rubber particles deposit themselves firmly on the paper fiber without any subsequent migration.

Combining the third and fourth question of this lecture regarding limitations, successes and the future of specialty impregnated products, let me say that our limitations are due only to the brief period of know-how in existence, to the lack of available time for fundamental research and to natural human reluctance to change

TABLE VII

Properties of Paper-resin Combinations—Saturation

	Untreated	Burna N	Natural rubber	Poly-vinyl-chloride	Plasti-cized poly-vinyl chloride[a]	Poly-vinyli-dene chloride	Plasti-cized poly-vinyli-dene chloride[b]
Bursting Strength, psi	11.0	57.5	54.0	35.7	69.3	42.9	61.9
Burst Factor	0.051	0.232	0.216	0.144	0.264	0.172	0.241
Tensile Strength, kg	1.60	4.56	5.16	4.87	10.00	6.24	9.73
Elongation, %	3.3	15.4	13.5	4.1	5.4	4.0	5.2
Tear Strength, g	107	426	408	301	416	251	333
Tear Factor	0.496	1.72	1.63	1.21	1.59	1.01	1.30
Stiffness, g	2.0	2.5	2.0	9.0	12.6	10.5	10.5
Porosity, sec	0.6	0.6	0.7	0.6	0.6	0.6	0.6
Valley Size, sec	0.5	18000*	18000*	1.7	38.9	793.1	18000*
Bulk, mils	42	40	39	40	40	40	39
Bulking Factor	3.51	2.91	2.82	2.91	2.76	2.89	2.74
Resin in Sheet, %	———	13.0	13.4	13.0	13.6	13.5	13.2
Basis wt, lb—25x40-500	216	248	250	248	262	250	257
Heat-curing Time, min	———	1	1	5	5	12	7
Heat-curing Temp. °C	———	130	130	150	150	150	150

All directional properties in machine direction.

[a] Contains 25% Santicizer B-16 as plasticizer.

[b] Contains 20% dibutyl phthalate as plasticizer. Plasticizer not included in calculation of resin in sheet.

* Indicates Valley size tester reading over 18,000 seconds.

Reference

Oliver, A. W. and O'Neill, P. W., Technical Association Papers, *30*, 426 (1947).

TABLE VIII

Effect of Laminating Pressure on Properties of Laminates

Molding Pressure (p. s. i.)	Average Ultimate Tensile (p. s. i.)	Average Stiffness in Flexure (p. s. i.)	**Average Izod Impact (ft.-lb./in.) of notch	**Average Distortion at 200° C. (in.)	24-hour Moisture Pick-up (%)
320	17,850	1,110,000	0.51	0.0070	1.78
2000	17,750	990,000	0.45	0.0069	1.43
*4000	17,190	1,060,000	———	———	———

* Thick specimen for heat distortion, impact, and moisture sorption samples flowed out from platens of press and could not be used.

** Tested edgewise.

TABLE IX

Results of Strength and Moisture Absorption Evaluations of Laminates Containing Varying Resin Contents

Durez Resin Added to Pulp (%)	Average Ultimate Tensile (p. s. i.)	Average Stiffness in Flexure (p. s. i.)	**Average Izod Impact (ft.-lb./in. of notch)	**Average Distortion at 200° C. (in.)	24-hour Moisture Pick-up at 25° C. (%)
Durez Resin 15553					
10	10,630	800,000	*1.11	0.0068	*71.55
20	12,210	860,000	*0.90	0.0055	*50.15
30	16,080	1,200,000	0.72	0.0052	44.67
40	14,630	990,000	0.66	0.0047	41.18
50	18,160	860,000	0.57	0.0049	12.42
Durez Resin 15535					
10	no tests	210,000	*1.25	*0.0079	*80.80
20	13,680	760,000	0.81	0.0048	50.14
30	15,170	780,000	0.65	0.0039	50.85
40	14,540	920,000	0.58	0.0041	23.00
40	16,800	1,180,000	0.58	0.0044	12.30
65	17,850	1,110,000	0.51	0.0070	1.78

* Samples split into one or more sections during cutting and machining.

** Samples tested edgewise.

paper making techniques established for many years.

Listing some of the more important limitations is difficult since each particular phase of our industry has its own special problem, but generally they may be stated as follows:

Cost
Ageing
Lack of permanent color
Recovery of broke
Lack of skilled personnel
Lack of suitable testing method for measuring stability and properties of finished product

The interest of the major chemical producers in this country on the subject of polymer paper treatments is tremendous, and tailor-made polymers can actually be expected if the need can be explained to the resin producers. They are ready and waiting, but it is up to the paper manufacturers and convertor to learn the basic science of handing these new colloids advantageously.

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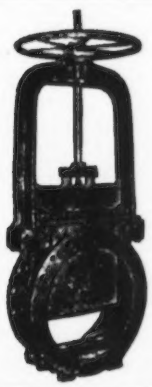
TABLE X

Retention Studies—Acetone and Beta-Naphthol Extractions

Durez Resin	Per Cent Resin Added to Mix	BETA-NAPHTHOL EXTRACTIONS *Av. Resin Extracted (%)	BETA-NAPHTHOL EXTRACTIONS **Av. Retention Efficiency (%)	ACETONE EXTRACTIONS *AV. Resin Extracted (%)	ACETONE EXTRACTIONS **Av. Retention Efficiency (%)
15553	10	6.30	63.00	4.23	42.35
"	20	10.05	50.20	8.65	43.25
"	30	15.17	50.60	12.56	41.85
"	40	23.10	57.80	20.75	51.85
"	50	29.10	58.20	23.00	46.00
15535	10	3.68	36.80	2.91	29.08
"	20	8.77	43.90	8.30	40.15
"	30	15.28	51.00	13.27	44.24
"	40	21.47	53.70	20.80	52.00
"	50	32.12	60.20	29.04	58.05
"	65	55.30	85.00	54.00	83.00

* Per Cent Resin Extracted = wgt. sample—wgt. extracted residue (100)/wgt. sample.
** Per Cent Retention Efficiency = ped cent resin extracted/fraction of resin added to moisture.

Sample Preparation:—Air-dry sheets ground to pass 10 mesh screen using Wiley Mill. Approximately 5% moisture in ground material. Results listed are average of two determinations, reported on an oven-dry basis.



RECORD PAPER & PULP STOCK VALVES "BONNETLESS" SELF CLEARING - - - "RESIDUE POCKETLESS TYPE"

METALS — I.B.B.M., all iron, bronze or stainless steels, body parts plain or rubber lined

The photo of 24" Fig. 241 I. B. B. M. valve while illustrating the gate bottom wedge system for forced gate seating and "GUILLOTINE" edge for shearing fibre at seat also shows the packing box and yoke as separate units. Both adjustable.

- The "FAST THREADED" screw stem and ball bearing speeds valve operation.
- The packing box is extra deep, is adjustable and provided with specialized lubricated packings and special type gland and compression bolts.
- The yoke mountings are such that yokes for various methods of gate operation are interchangeable.
- Replaceable gate edge shoes are used in valves 10" and larger. These shoes are of special value when valves are installed stem and pipe horizontal.

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Electrical Papers

Philip L. Staats
General Electric Co.

Philip L. Staats was born in Pittsfield, Mass., and attended school in that city. He graduated from the University of Toronto in 1942 with a B.A. degree in chemistry.

He came to the Pittsfield Laboratory of General Electric Co. in 1942 and became a member of the Chemical Section. After a tour of duty in the Army from 1944 to 1946, he returned to the Chemical Section, where he was made supervising chemist, paper dielectrics, in January, 1952.

Mr. Staats has worked with paper and high temperature dielectric materials, as well as other insulating substances, during his career in the Transformer and Allied Products Laboratory. He is the author of several publications and has been granted one patent.

The manufacturer of electrical apparatus converts the products of the paper industry into materials suitable for his particular equipment. The usages are many and varied but in general electrical machines depend on paper and paper products for dielectric insulation and mechanical structure.

Today there is little or no paper used in the electrical industry which does not undergo some kind of converting operation to make it suitable for use. Such operations involve slitting, rerolling, coating, shearing, folding, bending, treatment with insulating liquids, impregnating with resin, to mention a few of the modifications. With such varied materials, it is almost impossible to describe the individual requirements of paper products for general electrical use; our own specifications in many cases contain requirements which are of importance to some consuming plants but not to others. It will be necessary, therefore, to consider individually, the specific characteristics of several of the more common types of electrical papers.

General Requirements of Papers

There are, however, certain general items of interest common to all paper for use in electrical equipment. These considerations result in our concern in the paper process even at the primary stage, when the potential paper fiber is still in the tree. It is well known that the type of fiber influences mechanical properties and the type of sheet structure which results.

As an electrical consumer our interest is in strength, both electrical and machanical, purity and stability. At the present stage of development, three general types of fibers, coniferous wood, cotton and manila, are processed for use in insulating papers. The use of kraft because of its stability and purity has rapidly increased until at the present time, a very substantial portion of the electrical papers are made from kraft pulp. The fiber used has a very definite effect on power-factor, in fact, the degree of purity of the specified pulp itself has an influence on the power-factor characteristics. For pulp made from northern spruce, which is one of the most suitable fibers found to date for electrical papers, a very definite degree of chemical purification or removal of non-cellulosic constituents can be shown to be important for the most satisfactory loss characteristics of an electrical insulating paper. (1) Without considering at length the mill processes for manufacture of paper, we must mention the importance of these operations. Previously, it was mentioned that the electrical consumer was interested in dielectric strength, purity and stability of paper as general characteristics. The paper mill conditions can materially affect these properties.

Effect of Mill Conditions

Of prime importance in the manufacture of electrical papers is the removal of solid contaminates from the pulp suspension. The usual techniques as applied in the beater have been extended through the use of Centrifiners, Vortraps and Dirtecs. Dirt to the electrical consumer may mean conducting particles.

The residuals which the mill processes leave in the paper are extremely important. In this latter connection, we should especially consider acidity and alkalinity, electrolytes, additives, i.e. sizings and fillers and ash.

It is well understood that acid conditions in the paper have a serious degrading effect on the life of the insulating material. The measurement of the pH of the water extract of paper is one means of determining the degree of washing applied by the mill to the paper and to some extent it is an indication of the presence of sizings which are often accompanied by an acid condition. For example, a paper sized with rosin may have a pH of 4.5 while unsized 6.0-7.0 is expected. It is known that a size contributes to the dimensional stability; however, for certain electrical uses, even a small amount may be objectionable.

The presence of electrolytes in electrical papers is a problem which often causes considerable confusion to the paper manufacturer. The source of such contamination may be extremely fugitive. A consumer who produces a liquid filled electrical apparatus is particularly concerned with the possible presence of electrolytes due to their effect on the electrical characteristics and life of the insulating liquids. In general, the electrical industry desires that its paper be nothing but paper.

The ash value of the paper is a very definite indication of the purity of the material; for critical uses an upper limit in the order of 0.5 per cent has been generally established.

The degree to which the paper mill removes solid contaminating materials such as pieces of iron, copper or carbon has a very definite effect on the usefulness of a paper as insulation. The paper and electrical industry have gone to great expense to reduce these conducting particles to an absolute minimum. During the last decade, the par-

ticle counts per square foot on capacitor paper have decreased from over 20 to 1 or less.

With all due respect to these improvements, further decrease in conducting particles is necessary and is vitally important from an economic standpoint. Many insulating papers are as a routine measure given overall electrical inspection to preclude areas of low dielectric strength from use. When this process is not feasible, additional layers of dielectric paper are used to prevent failure. Therefore, manufacturing and material expense go hand in hand with the conducting particle count. (2)

The qualities of paper which can be influenced by the paper machine are of interest in so far as they affect the electrical properties of insulations; formation, moisture, density and porosity are some of the characteristics which must be controlled.

Under these conditions, the paper industry produces materials as thin as .0002" and as thick as .250". In order to more fully understand these products, we have established an arbitrary clasification of paper products based on usage (Table I). In this list are represented at least six kinds of paper and paper products. Using this classification, we shall attempt to discuss their properties and certain of the problems connected with their use.

Since many of the physical properties of paper can be influenced by a result from the type of machine used in their production, Table II shows the same papers listed according to mode of manufacture.

TABLE II

Selection of Electrical Papers by Method of Manufacture

Fourdrinier Machine Paper	Key Properties	Cylinder Machine Paper	Key Properties
Condenser Paper	Uniformity, thin thickness	Slot Paper	Tear, tensile
		Cable Paper	Tear, tensile
Saturating Paper	Uniformity, shrinkage, porosity	Pressboard	High thickness, dielectric strength
		Coil Paper	Tear, tensile dielectric strength

Specific Requirements for Paper Used in Electrical Insulation

1. Coil Papers

These insulations as their nomenclature designates are commonly used in winding coils and are at times referred to as layer or interlayer insulation. The thicknesses used range from .003" to .030"; the thicknesses up to .005" commonly being produced on Fourdrinier machines and having properties quite similar to condenser tissue which is described below.

Generally, kraft fiber is used for these papers and the material is waterfinished or otherwise machine calendered to present a smooth surface. Large amounts of such paper are slit and cuffed, i.e. folded on the edge to form a retaining wall for the wire layers. A more recent development has been the introduction of thermoplastic resinous coating which during the drying operation fuses and cements the coil turns to the insulating barrier.

The production of this type of paper involves close attention to tear, tensile, fold properties and naturally, volatile content. On the coated stock, care must be taken to maintain the proper volatile in order to prevent blocking or in the case of too low moisture enhance the possibility of cracking during the folding and winding operations. For the more rigid applications of this type glaze rolled rag papers are used, since higher fold and tear strengths can be developed than with kraft. Papers of this type, whose general characteristics will be discussed under slot liners, are offered to the trade in rolls, sheets and coils of folded layer insulation.

Considerable effort has been expended on these materials in an attempt to classify, standardize and determine their proper characteristics by A.S.T.M. The efforts of Committee D-9 has resulted in a draft of a specification for interlayer papers. This specification when complete, will carefully define the ash, pH, moisture, physical and electrical characteristics which the majority of electrical manufacturers believe necessary for proper layer insulations. It is restricted to unbleached kraft papers and definitely states that all contaminating materials must be removed and permits the use of no additives, sizes or fillers.

For very critical usage, layer insulation is overall tested for conducting particles. This procedure, which has been adapted by A.S.T.M. in Method D-202, involves the rereeling of the paper through an electrode assembly. At a predetermined voltage, generally 100-300 V/M, the conducting paths are detected and the faulty areas marked so that they can be eliminated from the electrical apparatus. *Figure 1* shows this equipment which many will realize is based upon a standard slitter frame.

The question of size in layer insulation papers has been confusing for many years; when supplied in sheets, rosin size has been very beneficial for papers in non-critical applications. This is, of course, due to improved dimensional stability which assists in the mechanical handling of the material. At

TABLE I

Classification of Electrical Papers by Usage

Material	Key Properties
Coil	High dielectric strength, tensile, tear, thickness
Pressboard	Thickness, physical strength forming quality
Condenser	Thickness, dielectric strength, very high stability, purity, uniformity, special electrical properties
Saturating	Uniformity, thickness, porosity, strength
Cable	Tensile, tear, special electrical properties, stability
Slot	Dielectric strength, tear, elongation
Vulcanized fibre	Dielectric strength, rigidity, forming quality, density

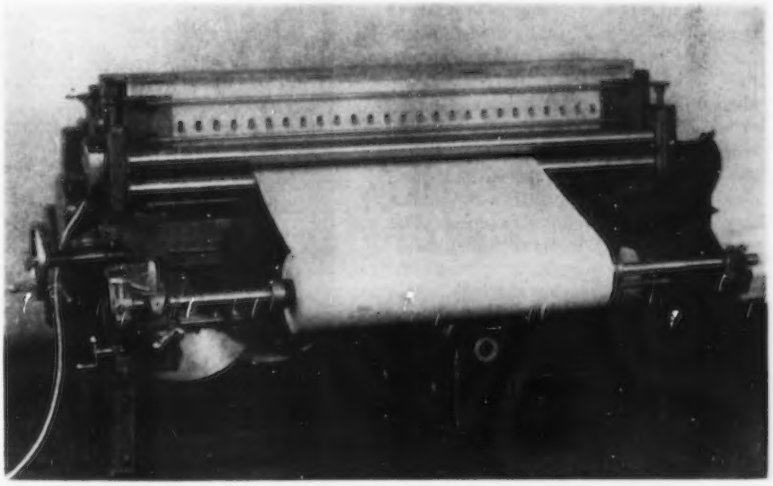


Figure 1. Paper and pressboard high-potential testing machine.

the present time, sized paper appears to be used to a much less degree, apparently due to the realization of the effect of the acidic condition on stability and other components of the apparatus.

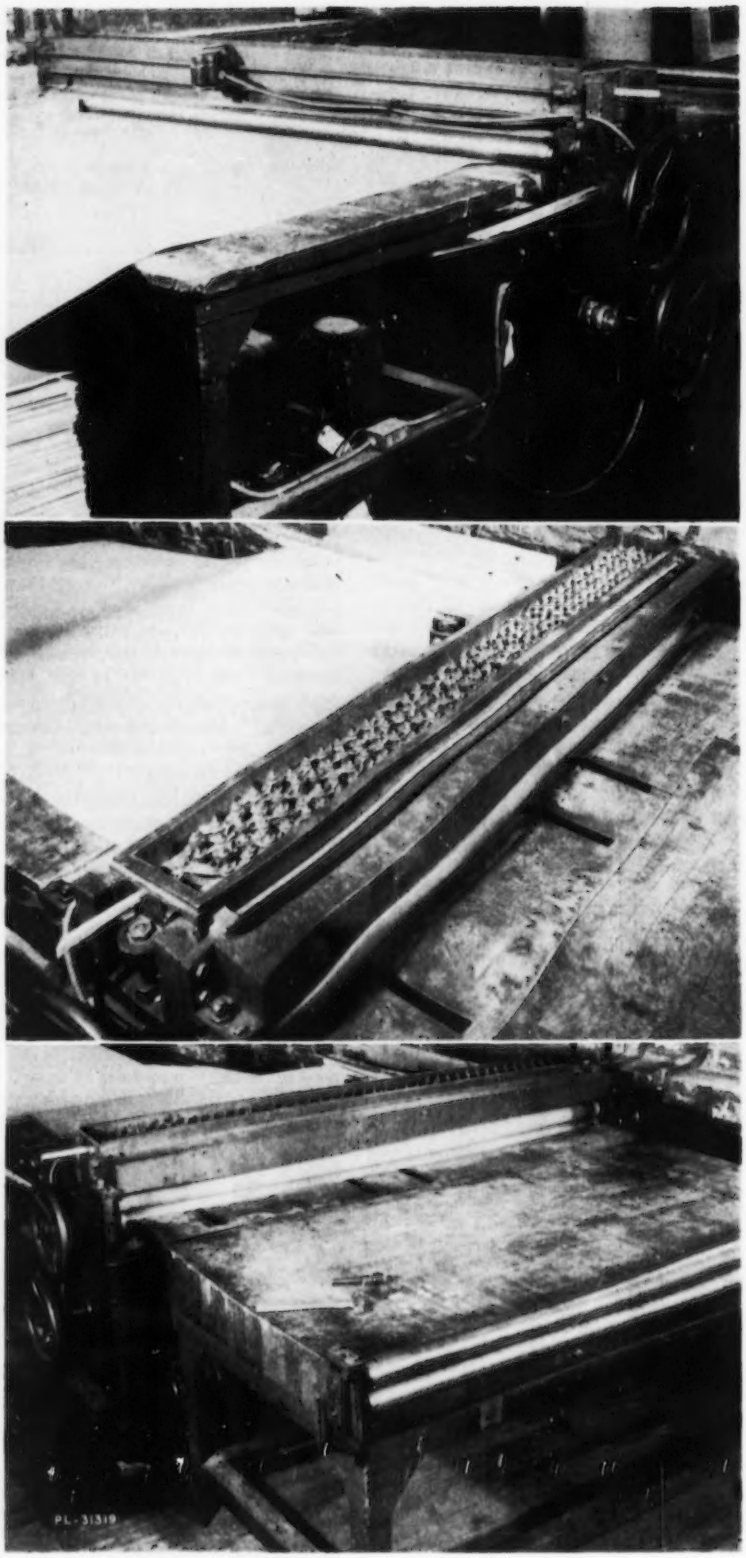
Pressboard

The heaviest types of natural paper products are the pressboards which are produced on wet machines in the form of sheets. Historically, these materials known in Europe as Presspahn, were made of 100 per cent rag stock; today various mixtures of rag and kraft, the most common being 45 and 75 per cent rag, and 100 per cent kraft are produced. These materials represent in many cases, major electrical and structural parts. Dielectric strength, rigidity, fold, forming quality, punchability and the proper surface are necessary characteristics. The large usage of pressboard is in transformer manufacture, where the material will be immersed in oil, and hence must be chemically neutral and not affect or discolor the insulating liquid.

Production of pressboard requires careful attention to foreign contaminates especially when rag fiber is used; since metallic inclusions are usually present in the new cotton cuttings. For this reason, some electrical manufacturers have established the process of dielectric inspection of the material. This method of test has been included in A.S.T.M. Method D-202 as Method C, for determination of conducting particles as in the case of some layer insulations. The burn-outs are marked so that these defective areas can be eliminated during subsequent fabrication of insulating parts from the board. *Figures 2, 3 and 4* show this equipment.

Since pressboard is a relatively thick and dense material, much of the equipment used in converting is similar to metal working machines; shears, bending devices and channel molds are common. For the best results, heat is applied during bending operations. In this process, moisture is extremely critical; if too high, blistering will occur; when too low, cracking will result. For complex molded pieces and draws moisture acts as an excellent plasticizer. The most satisfactory method for increasing the moisture content is by humidification. Proper venting of the press when heat is used is a necessity.

Material of greater thickness than available from the wet machine can be obtained by laminating, generally with water soluble adhesives. When less compressible material is needed, pressboard can be given additional calendering or pressing, and densities exceeding 1.30 gms/cc can be obtained. Mois-



Figures 2, 3, 4. Three different views of the equipment for dielectric inspection of pressboard.

ture content here again can be critical. Laminations made with synthetic non-aqueous resins require that a relatively low surface glaze be used, in order that penetration of the adhesive be attained. Too high a board surface will result in failure of the bond which is often characterized by partial delamination of the outside ply of the pressboard. *Figure 5* illustrates several formed and fabricated insulating parts made from pressboard. On the left are several punched and scored insulators and supports, at lower right a coil collar and a right angle bend. The large circular piece is a roller formed flanged collar and the samples shown within the collar show the drawing possibilities of the material.

Condenser Papers

At the opposite end of the thickness scale from pressboard are the lightest papers made commercially, the condenser tissues. Ranging in thickness from .0002" to .001", these materials are manufactured under closely controlled conditions from purified kraft wood pulp.

These papers were originally made from linen but kraft fiber was introduced in 1928. *Table III* illustrates the pulp and paper development which has taken place. At the present time, linen tissue is not produced commercially in this country.

It is not within the scope of this paper to describe in detail the various type of condenser tissue except to mention materials designed for d-c usage with high insulation resistance, for a-c with minimum power-factor properties. There are also electrolytic materials of semi-porous structure which may consist at least in part, of cotton or hemp fibers.

For the purpose of this discussion, the kraft tissues for uses other than electrolytic condensers will be considered. The properties desired by various manufacturers of capacitors of course vary somewhat, but in general, purity, stability, uniformity of structure and thickness are the outstanding requirements. Specifications generally limit ash, pH, resistivity of extract and soluble salts such as chlorides. Conducting particle limits as measured according to Method A of A.S.T.M. D-202 are always specified. The mechanical and physical qualities of air resistance and thickness are closely controlled as checks on the paper mills effort to produce a more perfect dielectric barrier. *Table IV* illustrates thickness tolerances on several thicknesses of paper.

As an additional control, some consumers have established electrical tests on the paper as quality control meas-

Figure 5. Formed and fabricated pressboard insulations.

TABLE III

History of Capacitor Paper Development

					→	Wood Kraft 1936 .0005" uncalendered High Mfg. Losses
Flax Linen To 1928 .0003-.002"	→	Wood Kraft 1928 .0005" Price and Stability	→	Wood Kraft 1933 .0003-.002"	→	Wood Kraft 1944 .0002" Space Factor
					→	Wood Kraft-Chemically Modified 1945 .0005" Improved P.F. and Greater Coverage

ures and for approval purposes. For d-c paper usage, the most common is an accelerated d-c life test and for the papers selected for a-c purposes, a dry power-factor measurement has been established.

Capacitor papers are manufactured on fourdrinier machines and finished by a separate supercalendering operation. The moisture content of the finished product must be carefully controlled and some mills and consumers handle their papers under conditions of controlled humidity. Due to the very low weight of these papers, they are extremely sensitive to variations in moisture content which cause cockling, wrinkling and soft rolls.

The manufacturer devotes considerable effort to the finishing operations; roll widths range from approximately one inch to somewhat above one foot. *Table V* shows the generally accepted width tolerances of condenser tissue. Extreme care is taken to produce rolls of uniform hardness and width with minimum number of calender cuts or nicks. The high speed winding machines with the size limitations of condensers make these controls an absolute necessity.

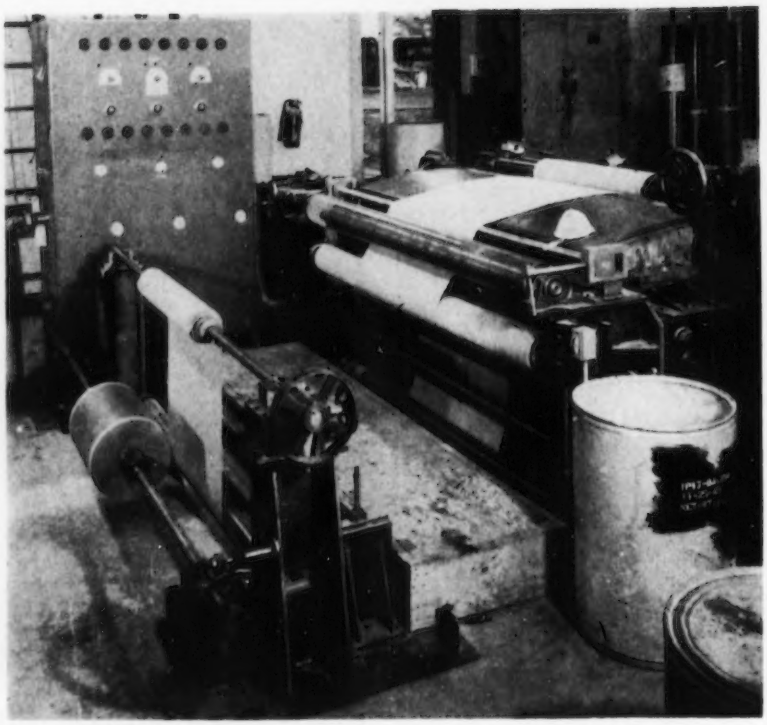


Figure 7. Group two winding machine showing heat transfer unit.

Saturating Paper

Those materials designed to act as the resin carrier and base material for industrial and electrical laminates, we classify as saturating papers. Such papers, generally of high bulk, are commonly made on fourdrinier machines. Uniformity of thickness and formation are extremely important since even

TABLE IV

Thickness Tolerances Condenser Paper

Nominal Thickness	Tolerance
.0002"	±.000015"
.0003"	±.000025"
.0004"	±.000025"
.0005"	±.000025"
.001"	±.0001"

TABLE V

WIDTH TOLERANCES CONDENSER PAPER

Width of Paper (inches)	Tolerance ± (inches)
½-3 incl	± 1/64
3-12 incl	± 1/32
12-18 incl	± 1/16

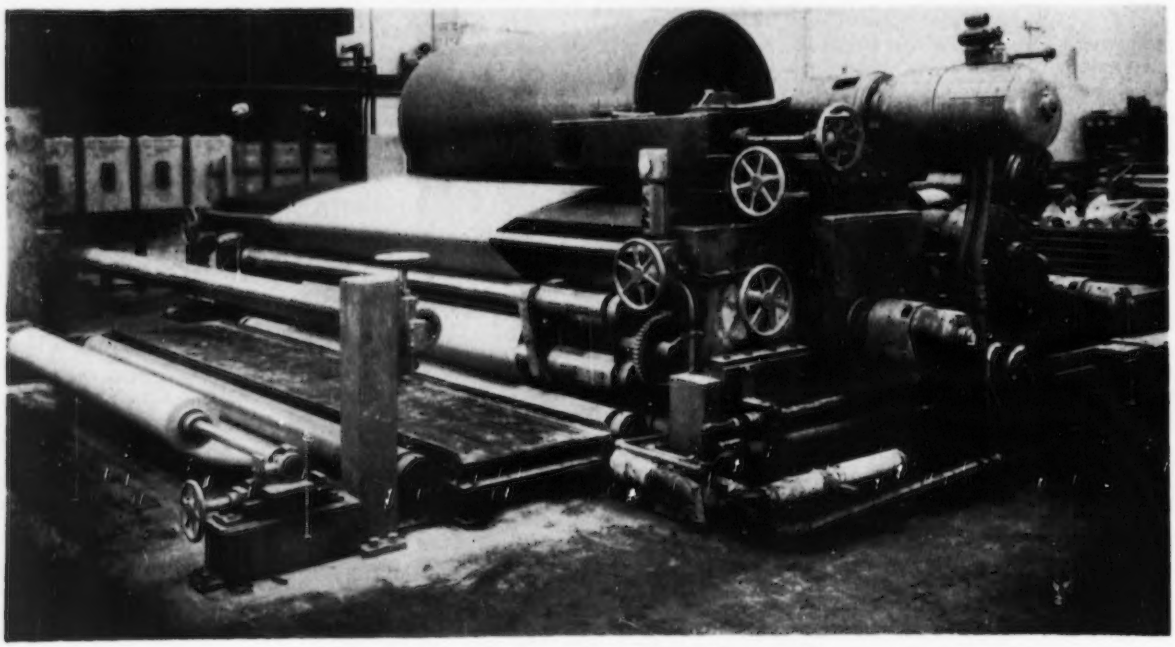


Figure 6. Overall view of large tube rolling machine.

penetration of the resinous impregnant is desired. A.S.T.M. specification D-1080-49T covers such papers made from cotton, alpha wood pulp and unbleached kraft.

According to the requirements of this industry specification, four types of paper are available; high absorbency material made from cotton, alpha and unbleached kraft; and medium absorbency, from kraft. As material for electrical usage, the usual requirements limiting foreign contaminating materials are specified.

Actual practice in the use of saturating paper depends upon the various laminators and their requirements. Seidel has shown through study of at least eight different base stocks including bleached soda, news broke and several krafts and sulphites, the effect of these furnishes on the properties of resinous laminates. From the point of view of mechanical strength alone, northern kraft is the proper selection (3).

Actual experience with saturating paper indicates that air resistance has an important effect on the ability of the paper to absorb resin. The Klim test for absorbency has been used; however, its value is somewhat doubtful due to the method of test which measures absorption along a strip of paper rather than through the material as in actual practice.

In the impregnation process the usual technique involves saturating the material in a solution of resin and then passing through a horizontal oven in which the paper is supported either by moving bars or air float. Solvent recovery often becomes an economic necessity in this process.

Due to the nature of this process, it is common for all specifications to limit the splices or breaks in the paper. The loss of material, treated with resin, due to paper breaks can be a serious factor in satisfactory impregnation.

For electrical uses laminates are produced in the form of sheets, rods, tubes and large structural cylinders as used in transformers. These materials in general require homogeneous structure which in turn is dependent on the formation and uniformity of the resinous impregnant in the paper. Several electrical requirements which often reflect the end use of the material such as dielectric strength parallel and perpendicular to the laminations, power-factor and various types of internal voids are tested.

Industry wide standards have been established by N.E.M.A. and A.S.T.M. specification D-709 for industrial and electrical laminates including sheets, tubes, both molded and rolled, and rods. *Table VI* shows a few of the general characteristics of type I or paper base

Figure 8. Shellac paper cylinders as manufactured at the Pittsfield works of the General Electric Co.

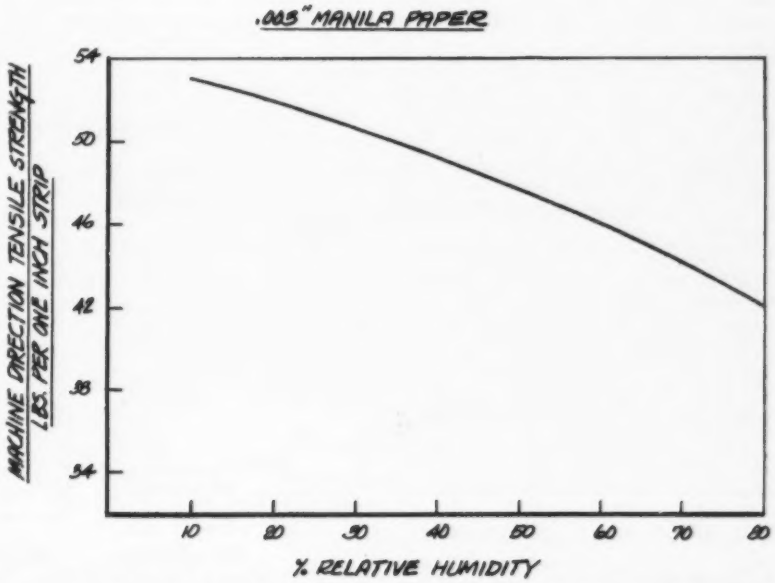


Figure 9. The effect of relative humidity on the machine direction tensile strength of turn insulation.

TABLE VI
STANDARD GRADES OF LAMINATES

Grade	Characteristics
X	Primarily mechanical
P	Hot punching, electrically better than X
PC	Cold punching, more flexibility
XX	Electrical use
XXP	Electrical use, hot punching
XXX	Electrical use, resistance to humidity
XXXP	Electrical properties better than XXX, hot punching

laminates. For purposes of brevity, we have included only general information on sheet laminates. *Figures 6 and 7* show several steps in process of manufacture of paper based resin structures for transformers and finished cylinders produced by the tube rolling process are picture in *Figure 8*.

Cable Paper

Traditionally cable paper or turn insulation has been made on cylinder machines from processed manila fiber. This material obtained from used rope is mechanically cleaned and separated, purified by chemical extraction and made into papers as thin as .0008". The characteristics imparted by the long rope fiber and the method of manufacture result in a flexible paper with high machine direction tensile and cross machine tear strength. Considerable emphasis has been placed on the development of tear strength. Much effort has been placed on the use of high strength kraft pulps for use in cable papers with a marked degree of success in many cases.

The use of kraft in cable paper has been influenced by market conditions of rope and the desire to obtain improved electrical properties. For commercial cables, emphasis has been placed on electrical tests such as power-factor. In many cases, the requirements for cable paper are as stringent as for capacitor tissue. Cloke and Bates (4) have studied the importance of air resistance on the breakdown of cable paper and shown the importance of porosity control in these materials.

Cable paper is supplied in universal bobbins and in pads or rolls; extremely narrow widths are used. The application of the material requires uniform rolls, free from cuts and nicks since breakage is a serious problem in wire covering. Experience to date has shown that inherent low friction properties of manila result in much more successful wire application than with kraft which apparently has a high coefficient of friction.

In order to obtain the most efficient wire covering, cable manufacturers have installed humidity controls similar to those used by the capacitor manufacturers. Examination of *Figures 9 and 10* shows how the benefits of this control affect the operation through the relationship of moisture to tensile and tear strength which are so important in wire covering operations.

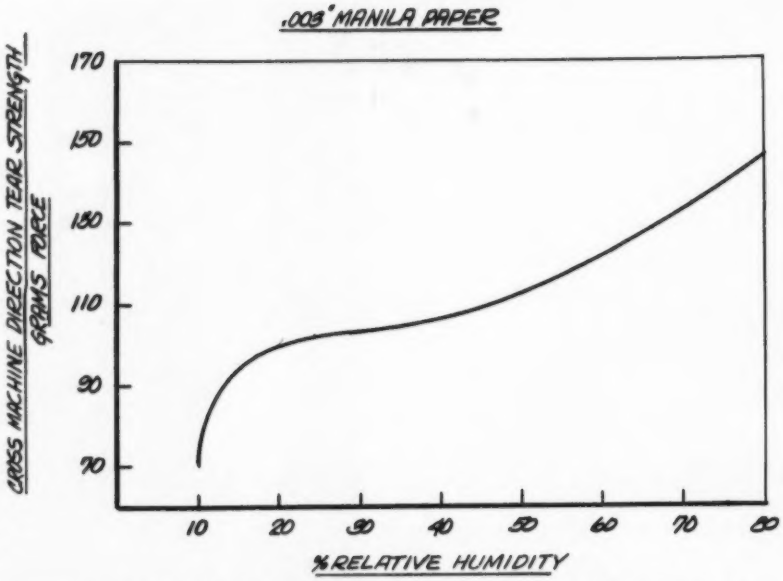


Figure 10. The effect of relative humidity on the cross machine direction tear strength of turn insulation.

Slot Papers

In the discussion of layer insulation, it was mentioned that for critical use, glaze rolled rag papers were used. These materials however, have their predominant use as slot insulation, hence this arbitrary classification has been established for purpose of discussion. Generally, these papers are made from 100 percent rag, although kraft pulps are being used to some degree, on machines of the cylinder type.

The manufacture of slot papers is quite specialized, involving selection and sorting of rags, magnetic separation of metallic particles, cooking, washing and beating the furnish to a high degree. The paper is finished generally by a glaze roll process which produces densities of 1.20 gms/ml and above. This high density results in excellent dielectric strengths in the order of 300 V/M. Sheets and rolls are available from different mills. *Figure 11* is

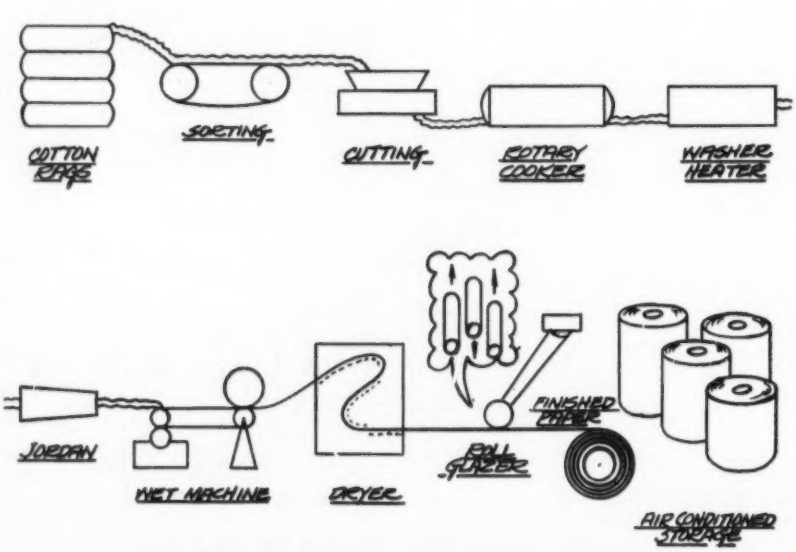


Figure 11. Manufacture of glaze-rolled rag paper.

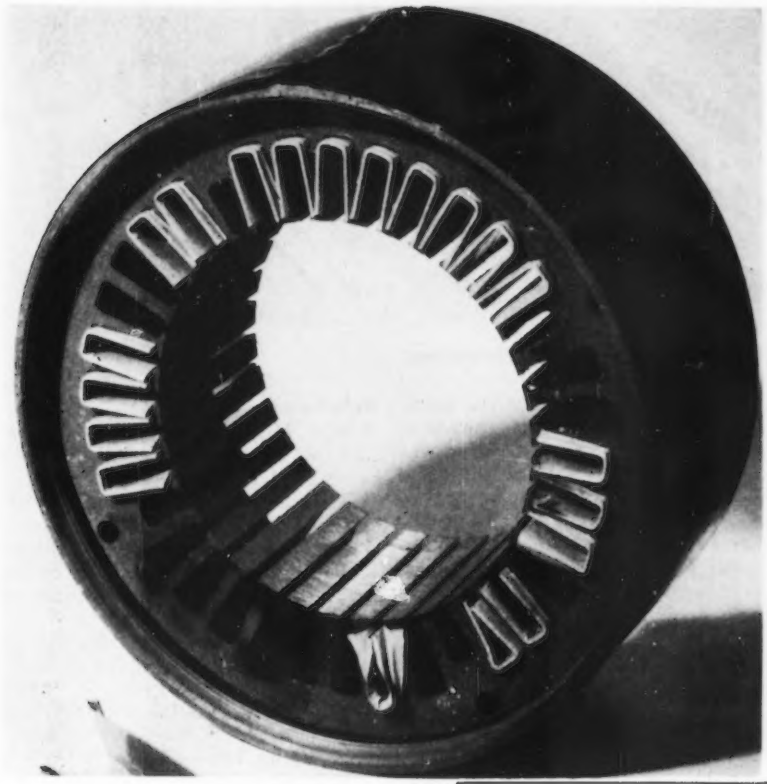


Figure 12. Application of rag paper as slot insulation.

a diagramatic view of this manufacturing process which has been included because of its specialized nature (5).

Characteristics of these materials are flexibility, elongation in the order of 5 percent MD and 12 percent CMD and tear resistance. By proper selection of the rags and processing procedure, low extractible grades are manufactured for use in such applications as hermetically sealed motors.

Figure 12 shows the use of such material as slot liner in a motor stator. The paper is folded and cuffed and must have sufficient mechanical strength to resist failure at the slot edges where it is subjected to the mechanical strain of winding. Certain manufacturers furnish the material coils with the cuff formed on the edge which permits more automatic application of the motor insulation.

Vulcanized Fiber

A paper product which must be considered in any discussion of cellulosic electrical insulations is vulcanized fiber. The term vulcanized has no relationship to vulcanization as used in the rubber industry but refers to a partially hydrolyzed cellulosic material.

By treatment of cotton paper with zinc chloride solution, a gelatinization of the cellulose takes place. This material when washed and compressed becomes vulcanized or hard-fiber. This material is supplied in such colors as black, red, white and natural gray. For the most critical uses, only natural gray is used. Fiber is extremely common in waste containers, tote boxes, protective equipment and certain machine parts. For electrical uses, it has certain advantages and, of course, some disadvantages.

All electrical specification on fiber place closely controlled limits on the zinc chloride and ash content. Thus the production of the heavier grades in the order of two inches thickness becomes extremely lengthy due to the long soaking or washing which may extend to one year. The material is used primarily as a structural insulation or where extreme mechanical stress precludes the use of paper; it has good arc resistance properties. Typical uses are in lightning arrestor tubes, fuse tubes, switches and switch gear and end insulation on motors. Rods are

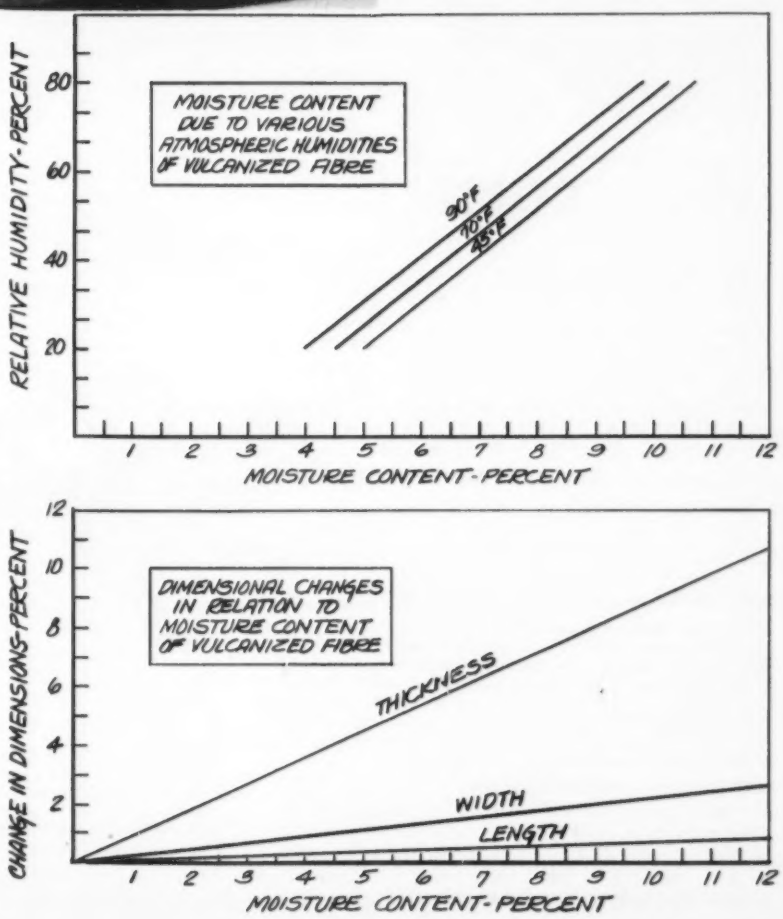


Figure 13. Effect of atmospheric humidity on vulcanized fiber.

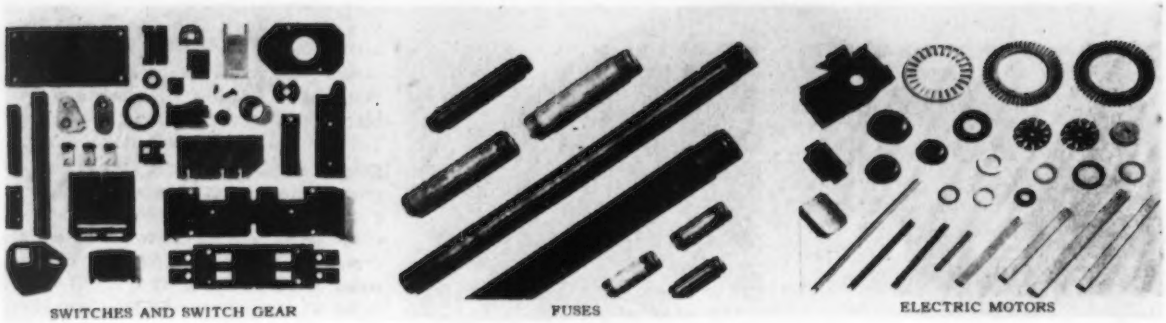


Figure 14. Vulcanized fiber insulations.

often used as insulating rivets or when threaded, as non-conducting bolts.

Like all paper products, fiber is sensitive to moisture and therefore for maximum dimensional stability must not be subjected to varying humidities. *Figure 13* illustrates this effect (6).

The fiber is available in sheets, rods and tubes and in the thinner thickness in rolls. By variations in the degree of gelatization and density products suitable for rigid structural use and for forming purposes are obtained.

Figure 14 is a photograph showing several insulating parts made from vulcanized fiber (7).

Our discussion of these papers has not included any consideration of inorganic papers such as asbestos, Quinterra, Micamat or glass. The problems occurring in the use of these papers are similar to those with the cellulosic materials but more complicated because of the generally lower strength characteristics. Their applications are similar to cellulosic papers but at temperatures which preclude the use of Class A material.

Electrical papers have general specification requirements and specific properties which are dictated by usage. The processing of these materials are similar to other industrial papers, involving consideration of the physical characteristics. The products, however, must always meet specific electrical needs.

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6. Spaulding Fibre Co.
7. Spaulding Fibre Co.

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Testing for the Paper Converter

E. E. Stephenson, Jr., and H. O. Wiles

Sutherland Paper Co.

We would like to begin our remarks by recalling a fable as old as Aesop. As a joke the fable is not new, may not be funny and certainly will not be told with skill, but it has one saving grace. It packs the tenor of our remarks into a nutshell. The "joke" is the aged one about three blind men who were led to an elephant and asked to describe the creature. The first man leaned against the monster's side and said, "It's a wall, a solid, leathery wall." The second man, feeling his way around a foreleg, stated unequivocally, "You're wrong, this is obviously a stout and sturdy old tree." The third blind man, approaching the creature from the front, said, "Ha!" You're both blinder than I. This is a writhing, squirming snake."

Unfortunately, most of our testing efforts restrict us to the limitations of the blind men. As you heard earlier in this series, we measure the "bursting strength" of a multiwall bag or a fiber shipping container. We say, "Aha! the Mullen is 280. This container is adequate for rail shipment to Timbuktu or Afghanistan."

We use a Bekk, Gurley, or Williams instrument to see how fast air will leak past the surface of an area of a piece of paper. "Oh no!" we shout. "This will never do. Fifteen seconds air escape means the sheet will never, never take a good printing impression.

Perhaps we, too, have a third blind man. He puts a drop of specially chosen oil on the surface of a sheet and watches it vanish instantly. "No oil resistance," he says, "this sheet will never take a good gloss ink."

Our three wise men of the laboratory are in the same boat with the three blind men and the elephant. They have each measured a leg, a trunk, or section of pachyderm sidewall and decided that it represents the whole beast.

Elward E. Stephenson, Jr. was born in 1924 in Indianapolis, Ind., and as a boy spent much time crawling over, under and around printing equipment of various types.

He graduated from Purdue University, Lafayette, Ind. in February, 1949, with a Bachelor's degree in Chemical Engineering; worked as a paper mill machine hand at Sorg Paper Co., Middletown, Ohio, and later as a chemist at the American Coating Mills, Elkhart, Ind. A year's work in paper technology at Western Michigan College, Kalamazoo, Mich., was followed by a connection with the technical department of the Sutherland Paper Co. in 1951. He is a member of TAPPI.

Harold O. Wiles was born at Columbia Falls, Mont. His academic training includes B.S. in chemistry Montana State College, M.S. in physiological chemistry and Ph.D. in agricultural biochemistry University of Minnesota. His professional career began with work on mineral nutrients in forage crops at the Tennessee Agricultural Experiment Station, followed by an appointment as Armour Fellow at the University of Chicago, with research involving the development of pharmaceutical products derived from animal tissues. Industrial proteins occupied his interest at the Experiment Station of the Hercules Powder Co. until he joined the Sutherland Paper Co. as biochemist in 1948.

Perhaps you will tell us the blind men were too hasty. They should have obtained ladders and crawled all over the elephant, feeling each square inch of his surface before they drew any conclusions. Then they would have been accurate. Would they? I doubt it. They would know nothing about the elephant's color, diet, native haunts, or habits. They would know only his external surface, shape and size. From this they might correctly infer many things, but they would really know very little.

Unfortunately, most of the testing of paper and paperboard parallels this process of elephant estimation. Most testing necessarily involves measuring a few external qualities, from which a great deal is inferred about source, use, characteristics and behavior.

Within the framework of our analogy, we might point out another factor of considerable importance. This involves the personnel needed for testing. An elephant dealer might employ many unskilled and semi-skilled men to measure different parts of the elephant; however, he must have something more than this. He must have at least one qualified elephant expert to supervise this measurement, and to draw conclusions from the findings. Good elephant experts, we might point out, are hard to find.

We face the same problem in any testing program we establish in paper converting. Even the most complicated test procedure may be learned by semi-skilled help in a relatively short period of time. The problem lies in choosing the proper test in the first place, seeing that the procedure for the test is suitable and is followed exactly, and, finally, interpreting the results of the test in such a manner that they will be useful. Training in the sciences related to the field is advisable and a broad practical experience is essential. The mere performance of a series of tests is, in itself, no guarantee of quality, but intelligent interpretation of test results can improve quality, increase efficiency, and reduce costs.

In addition to personnel, we must give some attention to surroundings. Since physical test results are usually influenced by temperature and humidity, conditions for these tests have been defined and standardized by the Technical Association of the Pulp and Paper Industry. The standard conditions are 73° F. ± 3.5° and 50% ± 2% relative humidity. For certain applications, conditions other than these may be specified, and most testing for production control is necessarily performed at ambient temperatures and humidities. Confusion or apparent contradiction sometimes results from comparing test data obtained under different conditions. It must also be remembered that paper retains some of the traits of its biological origin—that it continues to change for a long time after its production. In addition to temperature and humidity, good testing surroundings require adequate light, power, and storage space. Cleanliness of the area is essential.

Statistical Approach

No talk of this nature would be complete without at least mentioning statistical quality control. Since it is impossible for us to test every sheet of paper, every ounce of ink, or all of any given raw material, we must test a few samples from any large batch. The quantity and frequency of sample selection should be governed by statistical methods which in themselves do not fall within the range of this paper. We do feel however, that it is necessary to emphasize the fact that indiscriminate testing, as such, is not of great value, but that testing within the principles outlined by statistical methods can make the information from tests both valid and valuable. Statistical methods enable us to avoid wasted effort in over-testing and they aid in determining the minimum amount of testing required to obtain significant data.

Unfortunately we cannot further develop this subject of statistics here but it is a field worthy of additional study for anyone directly connected with a converting test program.

A Concept of Testing

Before we go any further, we may define a test as "any critical examination or decisive trial." Testing, therefore, begins at a very simple level in all operations. We look at our product and judge it critically. This is the simplest form of test. We compare the sample we have withdrawn with an example of the product we desire, either directly, (a carton in each hand) or mentally. This visual approach is the first examination. In addition to our eyes, we may use our other senses. We may taste or smell food packaging items. We may flex the completed article in our hands or run our fingers over the surface to feel the smoothness. In some cases, we may thump a container or rattle an envelope, using our ears in the examination.

Our critical examination may next involve measurement—or comparison involving a determination of the amount of deviation from a standard, within certain limits. We may measure dimensions, for instance, with a yardstick, a micrometer, or a gage block, depending on our critical limits and whether we need accuracy of 1/4 inch, 1/1000 inch, or 1/1,,000,000 inch.

Dimension, however, is only one of the factors in our critical examination. Since measurement of distance or dimension has been a recognized problem since man began to emerge from his origins, we have done much to standardize it. Since the first wheel was fitted to an axle or the first loin clout was tied to a waist, we have known that things must fit. We established early standards for comparison for length, using as standard the measurements of the king's left foot, or the distance between two marks scratched on a platinum bar.

Unfortunately, few of the other properties we must test and measure have such a well charted background or are based on standards as well defined as are those of dimension. We are also troubled by the fact that many of our measurements are based on methods less exact than those of length and cannot be measured directly but must be inferred from other knowledge. For instance (again referring to distance) we may measure the time it takes to walk one mile and then the time it takes to walk an unknown distance. From the second time, we can infer the distance we walked, but our accuracy is relatively poor on this indirect measurement, depending on many things, such as the accuracy of our watch, (an indirect measure of time in itself) our freedom from fatigue and variations in weather, road conditions and, of course, the accuracy of measurement of our "standard mile." The tests we must use in our evaluations are frequently much more devious than this example. We have many instruments, methods, and techniques of measurement, each selected to give us some information of use in testing.

Tests for Converters

Now we reach the questions: "What characteristics and measurements are of interest to us as converters?" "What kind of tests do we need?"

The answers to these questions cannot be given in simple terms. Each plant in each of the many converting fields has an individual problem. Tests of importance in one plant, may be useless in another. Workmanship in one plant may require frequent testing if quality is to be maintained, while another plant or process may require samples of minimum size and frequency. Due to the scope of the field we are attempting to cover in this paper, we cannot attempt to prescribe tests or test procedures but will be forced to generalize.

The tests of interest to us fall into three general groups. The first group includes tests designed to measure and control raw materials. For converters, these may include tests for the quality of paper, paperboard, foils, films, inks, varnishes, lacquers, resins, waxes, adhesives, and other components of the completed product.

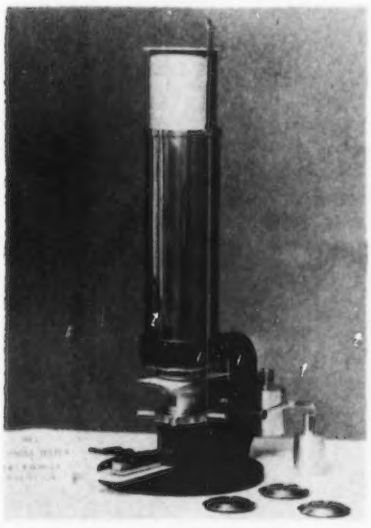
Raw Material Quality

Quality in raw materials is governed by a multitude of factors. If we consider paper, paperboard, foils and films, for instance, quality factors may be grouped under the following general headings: strength, physical properties other than strength, optical properties, chemical properties, biological properties, and electrical characteristics.

Basic physical properties important to all converters are basis weight and thickness, or caliper. The old truism that paper, paperboard and almost all sheet substances are bought by weight and sold on the basis of area makes the fundamental nature of these properties obvious. The determination of basis weight depends on two factors: (1) accurate measurement of area, and (2) accurate weighing. Within practical limits, the test area is usually fixed by tearing or cutting around a template that is dimensionally accurate. Weight may be determined on basis weight scales of many types with varying degrees of accuracy, or on conventional laboratory balances,

Thwing-Albert Basis Weight Scale. eccentric arm balances type.

Thwing-Albert Basis Weight Scale, an example of an equal arm balance type.



Gurley-Hill Softness, Smoothness and Porosity Tester.

either analytical, triple beam or eccentric arm types. Thickness is usually determined by using a dead weight micrometer, although pocket type friction micrometers are frequently found in converting plants.

Weight and caliper measurements may be combined to determine an apparent density. These three factors may be studied by men with a long background of experience in the paper industry to tell an amazing number of facts about this raw material. For a great many converting operations, measurements of weight, thickness and moisture content are sufficient for basic quality control.

The moisture content is frequently determined by methods quite similar to those used for the determination of basis weight. Samples are weighed, placed in an oven at 100-105° C, and re-weighed after drying. Numerous electrical devices based on either capacitance or conductivity are available for the rapid determination of moisture, and these methods have been very useful in the plants of many prominent paper converters where uniformity is of more importance than strict accuracy.

Other Physical Tests

Still other physical tests not directly connected with strength may be of considererable importance. These tests include smoothness, which may be determined in several ways. The Bekk, Gurley and Williams smoothness testers depend on the measurement of air leakage between sheets or between a sheet of paper and a plane surface. The Chapman tester evaluates smoothness optically through the use of prisms, and several devices based on mechanical measurement of surface irregularity are available.

Another property is porosity. This measurement indicates the air permeability of a sheet and is usually determined on a Bekk, Gurley, or Williams instrument. This measurement may be useful in a variety of ways. It may indicate operability on vacuum feeding equipment or potential saturation qualities for impregnation sheets. It also serves as a general indication of basic paper or paperboard formation and sizing.

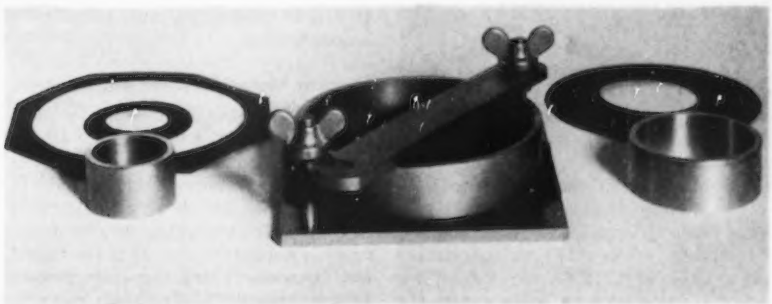
Liquid penetration is of fundamental importance in many converting operations. Most sizing tests are actually penetration tests. Many tests designed to measure the rate of penetration of water into paper have been devised and are in constant use. The Cobb size test and the water drop penetration test are two of the simplest and most widely used sizing tests. Other useful tests include the Carson curl tests, ink flotation tests, and several electrical resistance tests, as well as the dry indicator test.

For printing performance, waxing behavior, and saturating properties, the penetration of oily substances may be of considerable importance. In an evaluation for printing, the Vanceometer is often used to make this measurement, although oil drop tests and the "K and N" ink smear are also widely used. Wax dips and several techniques for temperature and pressure controlled penetration are the common means for testing gross oily penetration. It should be noted that this property is not necessarily related to water sizing.

Measurement of dimensional stability is quite important in many grades of converting sheet materials. Determination of hygroexpansivity, or the tendency to swell on moistening and shrink on drying, is fundamental in the evaluation of map and chart papers and many laminating grades. For these tests, precise dimensional measurements are made while the sheet is subjected to varying relative humidities.

Physical Strength

Physical strength and uniformity of strength are extremely important to many paper converters. Here the tests are familiar to most of us. For instance, it would be almost impossible to find an individual connected with the paper or paper converting trade who does not have at least a speaking acquaintance with the Mullen or "pop" test. The Mullen test is the oldest



Cobb Size Tester. These rings are used to measure sizing.

formal strength test regularly performed on paper products. Unfortunately it is not the simplest test to interpret. It is an indication of the bursting strength of paper and depends on density, tensile strength, tear and formation; however, it is frequently interpreted as representing all factors of physical strength.

Tensile strength is a basic property of great importance to many converters. Related to this test is one for the "stretch" of a sheet as a measure of the plasticity or ductility of that sheet. Tearing strength is another fundamental physical property. The internal tearing strength as measured by the Elmendorf tester is commonly recorded. This device measures the force required to maintain tearing once it has started. Edge tearing, or the force required to start a tear, may also be important.

Stiffness may be measured by a variety of instruments including Gurley, Clark, Taber, Suvant, and a Bureau of Standards torsion device. Compression resistance is closely related to stiffness and is usually determined by the Hinde and Dauch crush tester, the Reihle crush tester, or compression devices such as those supplied by the National Forge and Ordnance Company.

For many of the fine paper converters, and for other rugged uses, folding endurance is regarded as a basic property. This is usually determined on an M.I.T. folding endurance tester or on a Schopper tester. These devices repeatedly flex a sheet under a given tension until the sheet breaks.

Optical Properties

The next general group of raw material tests include those designed to evaluate the optical properties of a sheet material. The first project in this category is usually the determination of the color of the sheet. Color may be best defined by an integrating, recording spectrophotometer, such as the unit supplied by the General Electric Company. Various colorimeters and abridged spectrophotometers may be used where less exact color definition is required.

For practical work, paper color usually may be controlled by visual comparison. Comparisons, however, must be made under a uniform light source, since the color of the light itself has a strong influence on visual color matches.

Brightness is a term often met in paper making circles. This property must be distinguished from color. Brightness, as used in the paper industry has been rigidly defined as the percent reflectance of light at an effective wavelength of 457 ± 0.5 millimicrons, while color is a reflectance of the entire visible wave band. Brightness according to this definition may be measured with the General Electric brightness tester or with instruments supplied by Photovolt, Welch, Gardner, and others.

Many converting operations require a sheet with high opacity. Opacity as defined for paper making is not a simple reciprocal of transmittance, but is a ratio of the reflectance of a sheet backed by a black body to the reflectance of the same sheet backed by a white body. This method was chosen to indicate "show-through" of printed matter. Attachments are available for the Photovolt brightness meter, to adapt it for determining opacity, and the Bausch and Lomb Opacimeter is also available as a specialized instrument.

The measurement of gloss is of importance in certain applications. For strict interpretation this property should be measured with a goniophotometer. Most practical measurement in this field is done at a fixed angle on instruments such as the Vanceometer, the Photovolt with a "gloss" head, or the Ingersoll Glarimeter.

Additional Properties

Electrical properties of certain converting papers, particularly those used for insulation, are quite important. The properties most commonly measured include the following:

Dielectric constant, the ratio of the capacitance of paper to the capacitance of a vacuum.

Dielectric strength, or breakdown voltage.

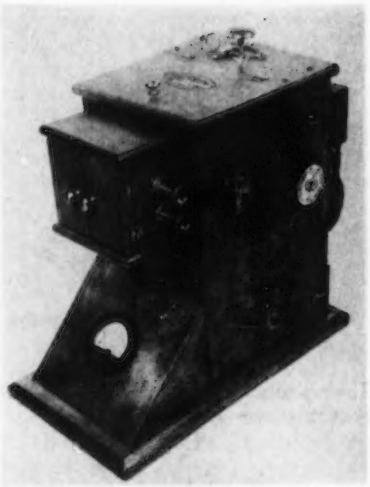
Dielectric loss, or power factor.

Additional requirements for paper include resistance to fading or color reversion. Samples are exposed in an Atlas Fadeometer and this fading is expressed in terms of exposure in natural sunlight.

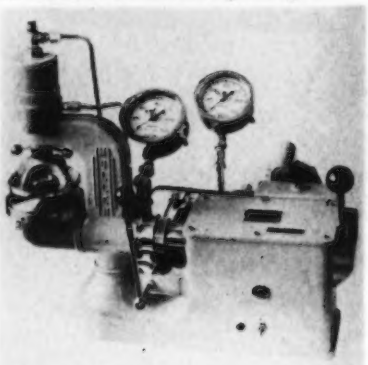
A multitude of other tests may be performed on the special converting papers. When special end uses are planned, these may include chemical tests for acidity or certain impurities, biological tests for many food papers, as well as microscopic and toxicological investigations.

Coating Materials

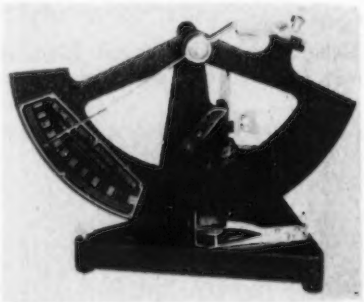
Inks, varnishes and some lacquers, resins, waxes and adhesives are all raw materials requiring certain basic tests. Properties of common importance include rheological, or flow characteristics, as well as body, tack and drying time. Despite the use of a few standard viscometers and the Interchemical Inkometer, most of these measurements are empirical and are based on



Valley Size Tester provides an electrical circuit for measuring sizing.

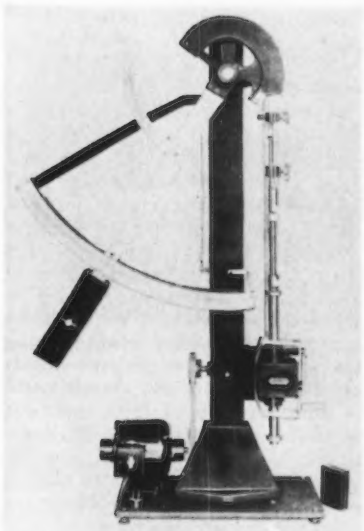


Heavy Duty Mullen Tester measures the bursting strength of heavy boards.

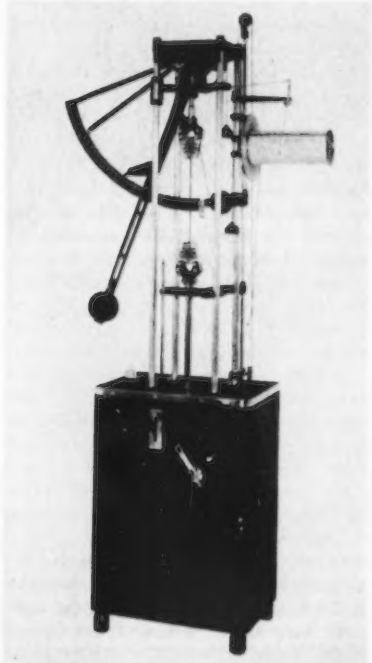


Elmendorf Tearing Tester measures the force required to maintain a tear.

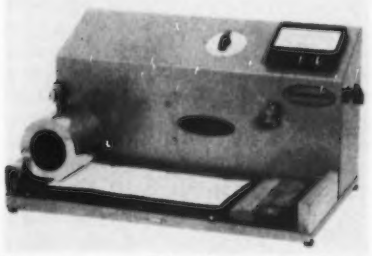
Taber Abraser measures the abrasion resistance of papers and paperboard.



T.M.I. Tensile Tester indicates maximum tensile strength and elongation at the point of rupture.



El Electro-Hydraulic Tensile Tester plots stress-strain relationships.



Vanceometer Oil Absorption Tester measures the rate of oil penetration.

practical requirements of the individual converter.

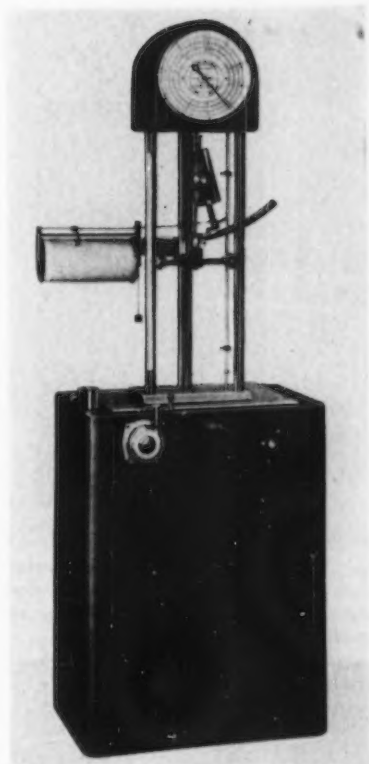
Since each of the raw materials mentioned above may be classified as some form of coating agent, the common tests are designed to predict performance in that capacity. The rate of congealing is of major importance and there are many tests based on a determination of this property. For conventional oil inks, simple "rub-out" tests are made at hourly intervals to estimate the probable length of time needed between printing and subsequent converting operations. Here, we have seen an example of drying where the concept is one of hours. For publication work, drying must be accomplished in fractions of seconds at elevated temperatures. Obviously, different techniques are required for such cases. Some organic coatings need certain curing or ageing times to develop properties ultimately sought in the coatings. Here, again, special considerations are involved in "drying" tests.

Pigments must be evaluated if they are components of the coating. Uniformity of color, particle size, obscuring power, chemical composition, and moisture content are typical of the factors important in such testing. Ease and uniformity of dispersion may also be measured.

In the final coating, many other factors may become important. Included in these may be the gloss or general appearance, the abrasion resistance, the chemical resistance, blocking tendencies, odor, color, or fading characteristics. These are generally approached by coating small samples of the various agents on paper or other sheet material similar to that to be used in the final converting operation, with the hope that results on these samples will approximate those to be obtained in full scale processing. The basic philosophy is one of trying the product on a small scale and attemping to eliminate or reduce failures before they have a chance to occur at the expensive production level. Many tests in the field of coatings have not been standardized, and the tremendous scope of the field with the many and varied end uses makes it improbable that full standardization will ever occur.

Special requirements usually associated with paraffin waxes used in the converting industries may include a determination of the melting point, tensile strength, yield value, cloud point, hardness, sealing strength, and flexibility, as well as many of the other tests mentioned for coating agents in general.

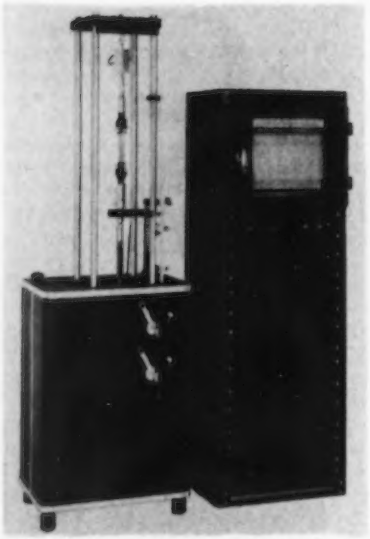
Adhesives must be checked for machineability on the particular type of machine where they are to be used.



Dillon Multi-Low-Range Universal Tester for stress-strain measurement of paper and other light-weight materials.

Mullen Tester measures the bursting strength of paper.

Hart Moisture Meter measures the electrical conductivity of a sheet.



RC Electro-Hydraulic Tensile Tester plots stress-strain relationships for paper in tension under a variety of conditions.

G-E Puncture Tester measures impact puncture resistance and stiffness.

R. D. Stiffness Tester is a motor-driven device for measuring stiffness.

Machineability is a broad term for a complex set of fundamental properties not easily analyzed or related to the requirements of high-speed equipment. In general, we know of no test method superior to a trial run using regular production machinery and techniques, after rough screening in the laboratory for bonding strength, water resistance, viscosity, tack, and ageing qualities.

It is important that suppliers and converters agree on tests that will serve to screen adequately without being unduly restrictive. Suppliers are almost always happy to cooperate in such programs since it is to their advantage to supply materials properly formulated for any specific job.

Converting Control

A second group of tests includes those necessary for maintaining an acceptable quality level in the various converting operations within a plant. These tests may involve uniformity of printing and color, bonding of adhesives, accuracy of physical dimensions and such things as odor, general appearance, and cleanliness.

These tests usually fall into a category of craftsmanship evaluation and are hard to restrict to standardized test routines. A converting operation may embody a number of specialized arts and skills which, blended with imagination, achieve a desirable and saleable product, but it is almost impossible to analyze the qualities of a "product of distinction". To a degree, this condition exists in many unit converting operations, such as printing, die cutting, laminating, etc. Many of these processes are handled by true artisans who are unable to define the various factors implicit in their art. However, as production is geared increasingly to absolute uniformity and large quantity, we must substitute tests and measurement for more and more of the things once regarded as implicit in craftsmanship.

Thus we may measure the color of an ink, or the thickness of a coating with impartial instruments, rather than rely entirely on the skill and judgment of an operator. We may test the surroundings of a converting operation by measuring the temperature or humidity of the atmosphere and so predicate our final expectations or intermediate adjustments in formulation upon these results.

A final inspection for visible flaws usually completes this phase of operations. This general problem of maintaining an acceptable level of quality throughout production is a fertile one for additional work. All too frequently, the technical man fails to appreciate the demands of a process which is largely an art, while the artisan fails to appreciate the need for testing or the nature of the techniques involved.

Functional Tests

We have discussed testing methods which are designed to help us answer the questions: (1) Are the raw materials suitable or as specified? (2) Have our converting operations been carried out satisfactorily? As you have seen, these tests are usually, but not always, simplified in their design so as to test only one factor at a time. This analytical approach is essential if we are ever to measure and control all the factors which comprise the characteristics of the product. We come now to the third category of tests, and ultimately the most important. These are the tests which help us to answer the question, "Will the product do the job for which it was made?" These are the so-called *functional* tests.

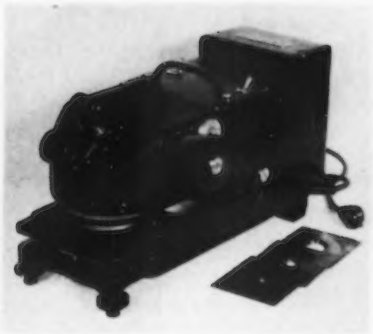
Functional tests are necessary for several reasons. We must be sure that a wise choice was made in selecting or specifying the raw materials, and that unforeseen sources of trouble have not eluded us in our converting operations. Most of all we must insure that the product will be satisfactory in the hands of the people who use it. There are many reasons why products fall short of full satisfaction—the effects of improper packing, shipping, and storing, damage as the result of the vagaries of weather and climate, of ageing, of decay or corrosion, plus all the uncontrolled happenings which result from human misunderstanding or carelessness. Functional tests, then, may be used to evaluate new products, to test the adequacy of our manufacturing methods, to demonstrate the suitability of products in normal use, to determine the approximate limits of abuse which they will tolerate (safety factor), and sometimes to find a fair and informative answer to customer complaints.

Obviously the field is too wide for us to attempt to enumerate or describe all the special tests. A few basic considerations and a few examples must suffice. First, to be valid, a functional test must be *realistic*. Attention must be given to conditions of temperature, humidity, test mediums, normal filling, representative weighting or stacking, etc. The item must be completely assembled with respect to liner, inserts, adhesives, and fastenings, unless these definitely can be excluded from consideration. Second, functional test conditions may frequently represent the extremes of normal use, which usually implies a considerable degree of abuse or misuse.

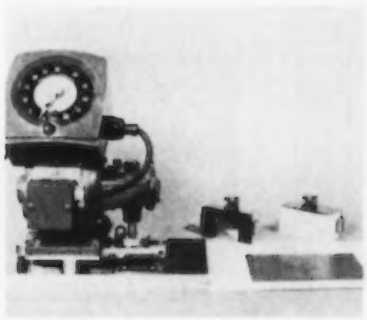
Accelerated Tests

There is a considerable demand for accelerated tests with their attendant

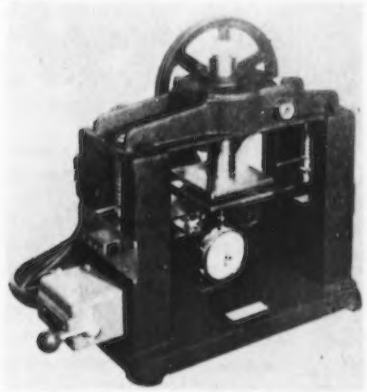
General Electric Brightness Tester, as standardized by the Institute of Paper Chemistry, is the accepted basic instrument.



Gurley Permeometer measures the air permeability of extremely porous papers and textiles.



Sutherland Ink Rub Tester subjects printed ink films to a standardized rubbing action.



Hinde and Dauch Crush Tester measures the crush resistance.

Photovolt Photoelectric Reflection Meter, with attachments shown, may be used as a brightness meter, a tristimulus colorimeter, or a gloss meter.

G-E Recording Spectrophotometer records exact color.

savings in time, extensive equipment and other expense. Accelerated tests are certainly much to be desired, but if they are not intelligently carried out and interpreted they can be entirely misleading. An accelerated test is of dubious value if the product or the testing medium is physically modified by the conditions of the test. It is also of questionable value unless a relation can be shown between the results of the accelerated test on one hand, and the changes accompanying normal storage or use on the other. It is true that we can obtain valuable qualitative information by using extreme test conditions, such as the effect of strong ultraviolet light on the color of inks, or the rancidity of fats, but such a test is not realistic as a functional test until it can be correlated with use characteristics of the product.

Simulated Conditions

It is often necessary to employ simulated conditions which, while not duplicating all the conditions the product may encounter in use, have the virtue of reproducibility. Such a test may be employed to study deterioration of perishable items. The packaged material is carried through a cycle of exposure which may follow a tabulation such as this:

1 Week at 36°F. (Simulating normal refrigeration storage)
1 Day at 72° F. (Simulating transport in trailer to jobber)
3 Days at 40° F. (Simulating jobber's storage)
4 Hours at 90° F. (Simulating local distribution)
2 Days at 40° F. (Simulating retail storage)

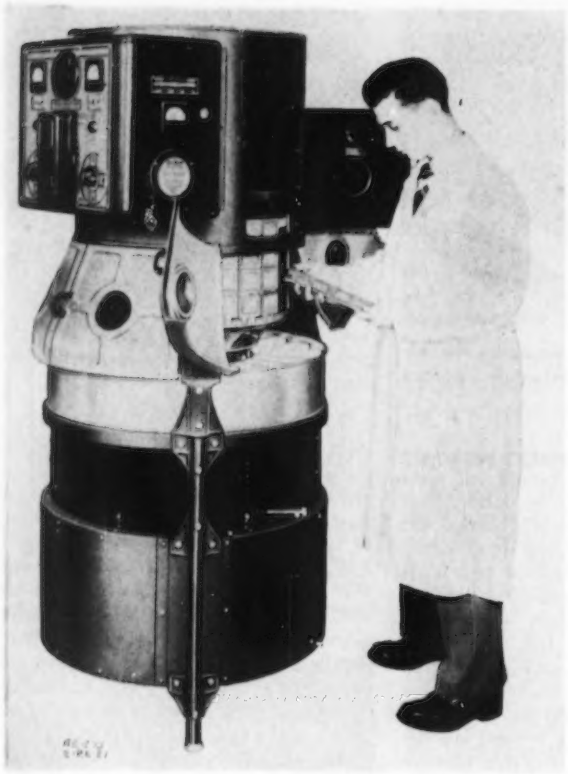
Both material and package are then examined for quality and nature of deterioration if any. Similarly, cycles of controlled temperature and humidity are set up to test the tendency of sheets to curl, or containers to warp.

One class of paper products which almost defies heat-accelerated tests is the rather extensive group of paper products which incorporate thermoplastic adhesives, coatings and the like. If, for example, a board with a barrier coating of paraffin wax, melting about 133° F., is subjected to oven heat at 150° F, the coating sinks into the board but does not saturate it. The barrier layer has been lost: the test is destructive. Similarly wax laminated sheets will delaminate with excessive heat. Again the test is destructive if excessive heat is applied.

Test Mediums

It is often advantageous to use test mediums which only simulate or parallel the usual packaged material. There are several references to the use of mineral oil, sweet butter, milk chocolate, water, etc. for studying the transfer of odor from packaging materials. These test mediums may aid materially in isolating or classifying the odor by virtue of selective solubility or easy detectability, and they have

Tinius Olsen, M.I.T. Folding Endurance Tester flexes a sheet under constant tension and records the number of cycles required for breaking.



Atlas Fadeometer. Controlled exposure to an arc light is used in this machine for testing light fastness and color reversion of papers and inks.

the additional important property of being palatable or at least inoffensive to the tester. Some care should be used in selecting the simulated test materials, especially if it is in the category of fatty or waxy materials. Rancid fats, for instance, may be much more destructive than fresh bland fats; on the other hand, mineral oils do not necessarily parallel animal or vegetable oils in their penetration and other characteristics.

It is apparent that functional tests may be devised or adapted as the need arises. Once a test method has been worked out and adopted, it should be written in detail and followed in subsequent testing.

Standard Methods

Wherever possible we should try to use methods which are accepted as standard or official in the control of raw materials, converting operations and product evaluation. Now we might ask, "How do we run these tests? What methods do we use?"

Exact procedures and descriptions of equipment for hundreds of tests have been compiled by several groups. In many cases, the methods of these groups overlap or coincide in part. For most of the work in the converting field, one or more of the following compilations of standards will provide a sound base for testing:

A.S.T.M. Standards (Published by the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.)

TAPPI Standards & Routine Control Tests (Published by the Technical Assn. of the Pulp & Paper Industry, 122 E. 42nd. St., New York 17, N. Y.)

Packaging Institute Test Procedures (Published by the Packaging Institute, 342 Madison Ave., New York 17, N. Y.)

In addition to these sources, the National Bureau of Standards published a brief circular on paper testing, and members of the Institute of Paper Chemistry receive a collection of "Institute Methods". Federal Specification VV-P-31b also contains general test methods and specifications for paper. The manufacturers and suppliers of testing instruments are usually very helpful in supplying information and calibration service.

New Methods

Frequently new products or new requirements on the part of consumers bring about a need for tests not specified in one of the above references, or individual situations require some modifications. When this occurs, a little inventiveness is usually required. An example of this which is familiar to the authors, is the evolution of the "Sutherland Ink Rub Tester" for the evaluation of rub resistance of inks. No adequate instrument or procedure was available until this rub tester was developed by the Sutherland Paper Company. In the year that it has been available, over 70 instruments have been purchased by converters and ink makers. Other examples of similar development include the Hinde and Dauch crush tester and the Dennison waxes for pick testing. In short, if there is no test procedure, establish one or modify some existing test to meet your needs. To return to the elephant analogy, we can seldom measure the entire elephant, but we can usually find or devise a method for testing the part of the elephant that is important to us.

Photographs of many instruments frequently used in the paper converting industries are included. These pictures represent only a small fraction of the many instruments that are available and we do not mean to imply that the instruments shown are necessarily the most important instruments in the field. Each converter has his own special problems and his test instruments may be of little value to another.

Summary

This leads to a final series of comments. We must give serious consideration to the tests we *do not* run as well as to those we *do* run. There is no point in spending time and money on tests merely because tradition calls for these tests. For example, odor evaluation is extremely important in making bakery bags or cartons, but it would be a waste of time to control odor on a run of bags for sheepmanure or some equally fragrant fertilizer. Similarly, grease resistance is of paramount importance in a potato chip bag, but ridiculous in blotting paper. Tests should be run when they are needed and when they will represent a return to your company in the form of increased economy or a reduction in the production of unacceptable merchandise.

We are sorry that it has been impossible to list all applicable tests and that we have not been able to say "Testing is easy. Buy these three instruments and you have everything you need to assure perfect production."

We do hope, however, that we have been able to introduce testing for the paper converter in its proper perspective and that we have been able to bring some amount of organization to a relatively confused subject.

"Paper conditioning the modern way"

Vapo Systems Co.

ANNOUNCES

31

OUTSTANDING MILLS IN THE UNITED STATS, CANADA AND MEXICO HAVE ADOPTED VAPO SYSTEMS.

12

OF THE LARGEST WAXPAPER CONVERTERS HAVE ADOPTED VAPO SYSTEMS

YOUR INQUIRIES ARE INVITED

VAPO SYSTEMS COMPANY

P. O. BOX 309 VILLA PARK, ILLINOIS

PHONE 7678

INCREASE BEATER PRODUCTION WITH

TAYLOR-STILES RAG CUTTERS

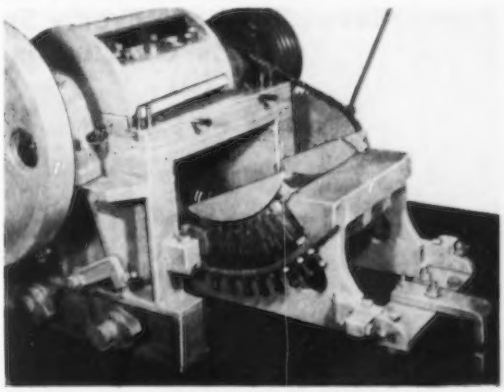
Tandem Cutter that cuts and cross cuts rags for fine papers.

Rags cut into small uniform pieces on modern Taylor-Stiles big production cutters add greatly to the capacity of the beaters in efficiently equipped roofing and fine writing paper mills.

In a typical installation four new Taylor-Stiles Rag Cutters made it possible for 8 beaters to do the work of 14.

Taylor-Stiles Rag Cutters are of Three Types:

1. ***Tandem cutters*** **which are composed of two cutting elements that cut and cross cut the rags. (illustrated above)**
2. ***Multiplex Cutters*** **in which a gang of supplementary bed knives reduce the rags to exceedingly small pieces.**
3. ***Single Production Rag Cutters*** **that cut material in one cutting operation.**



This shows how the cradle of supplementary bed knives is arranged in Multiplex machines.

TAYLOR, STILES & COMPANY

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Owners of machines incorporating Chief Sandusky non-ferrous centrifugal castings such as roll shells, covers, and liners can be confident they have their best.

For more than 40 years, leading machine builders have been using them for these and similar applications. Every casting has that superior quality which results from Chief Sandusky's leadership in metallurgical knowledge and production skill. "Sandusky" pioneered centrifugal casting. Today its research programs, both inside and outside the organization, continue to improve non-ferrous casting quality for the benefit of the machine user. Be sure to get the best.

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Improve Your Slitter Operation!

Mount Hope FREE WHEELING EXPANDERS

Keeps Paper Wrinkle Free
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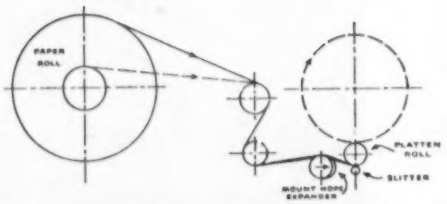
Prevents Overlapping



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Mount Hope Ball Bearing Free Wheeling Expanders completely eliminate wrinkles and baggy edges that cause out-of-register printing. Equally effective on all types of machines, on wet or dry paper. Save time and money throughout your plant!

Have a Mount Hope Engineer study your problems without obligation—or send for free Bulletin EXP.

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Address replies to advertisements appearing under Box Number in care of **PAPER TRADE JOURNAL, 15 West 47th Street, New York 36, N. Y.**

HELP WANTED

MEN WANTED—POSITIONS OPEN

We can place—Plant manager or gen. supt. roofing paper felt, asphalt roofing and related products, including asphalt compounds technical director; personnel mgr. (southern plant); box shop supt.

Chemical or mech. engineers to sell paper mill equipment, dyestuffs, chemicals and adhesives; plant engineer, salary range $8,000-$10,000; foreman semi-chemipulping operations; head for new research dept.; color matcher coated papers; Cylinder and Fourdrinier mach. foremen (several); designers and draftsmen; master mechanic (New Eng. mill) salary $125-$150 wk.

LIST YOUR APPLICATION WITH US. IT WILL BE CONFIDENTIAL.

CHARLES P. RAYMOND SERVICE, Inc.
Phone: Liberty 2-6547
294 Washington St., Boston 8, Mass.
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CHEMIST

With Box Board Mill experience for mill located near Chicago. State experience, age and salary expected. Reply to General Offices, NATIONAL BISCUIT COMPANY, 449 West 14th St., New York, New York.
N-20

Man thoroughly experienced in manufacture of Kraft Tissue and Carbonizing Grades to act as assistant to Superintendent. Applicants must have experience as Machine Tender or Tour Boss on Carbonizing Grades. Mill located in Southwest. Applicants please state experience and salary required in first letter. Addres Box 53-465 care Paper Trade Journal. N-20

ASSISTANT SUPERINTENDENT

We are a Wisconsin paper mill which has gradually expended for a number of years, so we are now looking for an Assistant Superintendent. This man would hold a position of great responsibility in our mill, so he must have practical experience as a papermaker plus administrative ability. The right man probably has held, or now holds, a similar job in another mill, but has some good reason to make a change. The salary will be in proportion to the ability he can bring to us. In addition, we have complete group insurance protection, paid for by the Company, and an excellent profit-sharing retirement plan. Apply by letter giving your complete background and qualifications to Box 53-457 care Paper Trade Journal. Your replies will be held in strict confidence. N-27

PAPER MILL SUPERINTENDENT, TOUR FOREMEN (2)—For established groundwood printing and specialty mill. Tour Foremen not over 40 years. Superintendent not over 45 years. High salaries and excellent opportunities for right men. Address Box 53-463 care Paper Trade Journal. N-27

HELP WANTED

MAINTENANCE SUPERINTENDENT

Pulp and newsprint mill now under construction is developing its permanent organization and has need for Maintenance Superintendent. Will report to Chief Engineer and direct all maintenance functions through several Maintenance Foremen. Experience in supervision of maintenance activities in pulp and paper industry is essential. Address:

Industrial Relations Department
Bowaters Southern Paper Corporation
CALHOUN, TENNESSEE
TF

WANTED

MANAGER FOR PAPER DISTRIBUTOR IN FAR EAST. WE HAVE AN OPPORTUNITY FOR A CAPABLE MAN WITH SOME EXPERIENCE IN HANDLING FINANCES. NO FOREIGN LANGUAGE NECESSARY. MUST BE SINGLE. PREFERENCE WILL BE GIVEN TO PERSON WHO HAS TRAVELED OR LIVED IN FAR EAST. GIVE FULL DETAILS OF EXPERIENCE AND PERSONAL HISTORY TO BOX 53-449 CARE PAPER TRADE JOURNAL.
N-20

SALARIED POSITIONS $3,500 to $35,000. We offer the original personal employment service (established 43 years) Procedure of highest ethical standards is individualized to your personal requirements. Identity covered; present position protected. Ask for particulars. R. W. BIXBY, INC. —117 Dun Bldg., Buffalo, 2, N. Y.
N-13

WANTED—Quality Control Engineer to install and supervise quality control group in corrugated box division of Midwestern Plant. Young man with experience in both quality control and production preferred. Address Box 53-354 care Paper Trade Journal. TF

WANTED—Machine Tenders and Back Tenders for Tissue Mill, cylinder machine. Also, Machine Tenders for 5 cylinder machine on Folding Boxboard. Good pay. Rapid advancement. Address Box 53-364 care Paper Trade Journal. TF

SUPERINTENDENT experienced flat and square bags. Bagprint, Matador, Potdevin, etc. Some knowledge of printed bags useful. Excellent opportunity for permanent future. All replies confidential. Address Box 53-402 care Paper Trade Journal. TF

CHEMIST—B.S.—Opportunity in Packaging Division of food company laboratory located N. Y. C. One years experience in packaging desirable. Salary open. State age, experience, education and salary expected. Address Box 53-458 care Paper Trade Journal. N-13

WANTED—Top-notch Adjuster for Potdevin Self-opening bag machines. Good pay. Metropolitan area. Address Box 53-450 care Paper Trade Journal. N-13

SITUATIONS WANTED

MECHANICAL-INDUSTRIAL ENGINEER, 31. Paper, Packaging background. Experienced manufacturing, cost reduction, plant engineering, materials handling, equipment design, product development, sales. BSME, BA Chemistry, veteran. Address Box 53-399 care Paper Trade Journal. N-13

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SUPERINTENDENT — Thoroughly experienced on all grades of folding and set up box board, also test liner. Excellent references. Address Box 53-455 care Paper Trade Journal. N-13

GENERAL SUPERINTENDENT—30 years experience on free sheet book, bond, writing, offset and similar papers. Also an expert on groundwood specialties. Wish position as general superintendent or manager any size mill. Will go anywhere. Welcome Latin American or Canadian service. Good reason for wishing change. Address Box 53-466 care Paper Trade Journal. N-20

GRADUATE CHEMICAL ENGINEER AVAILABLE—Eleven years practical experience in development and quality control in pulp, paperboard, converting, including coatings, resins, adhesives, inks. Desires increased responsibility. Address Box 53-467 care Paper Trade Journal. N-13

SUPERINTENDENT or Tour Foreman with many years of practical papermaking on all grades of boxboard. Capable of assuming full responsibility for production, quality and personnel problems. Best of references. Address Box 53-464 care Paper Trade Journal. N-27

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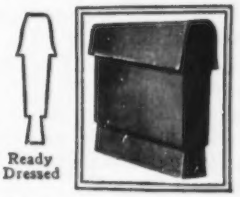
READY DRESSED

MILL COGS

LABOR SAVING TIME SAVING



The most economical filling that can be put in a mortise wheel

QUICK SERVICE
ON ALL SIZES

Write for Instruction Sheet "G" which is free

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BRUSHES
for
PAPER COATING
DAMPENING
POLISHING
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GUS RIEDEL & SON
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FOR SALE—Sheridan 8-D four-rod Embosser, maximum sheet 35 x 46. Excellent condition, hardly used. Address Box 53-456 care Paper Trade Journal. N-13

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We are authorized to Sell Promptly:

1—84" Single Cylinder Paper Machine with pick up felt, Dryers 48" dia., Calender Stack, Continuous Reel, Cameron Winder. Complete in all respects, back drive, etc. Can be seen on original foundation

1—76" Single Cylinder Paper Machine with pick-up felt, Dryers 48" dia., Calender Stack, Continuous Reel, Cameron Winder. Complete in all respects, back drive etc. Can be seen on original foundation.

4—Good Cast Iron Beaters. 1—800# Pulper with motor and pump.

1—Dezurik Consistency Regulator with Motor etc.

1—76" Hamblet Sheeter with 24 roll backstands, folder and motor.

1—Bank Transformers 1100 K.V.A. 4800 Primary, 3 - 60 - 440 secondary. Plunger and Centrifugal Pumps, mostly motor driven.

2—Banks of Capacitors 105 K.V.A. and 120 K.V.A. 460 Volt, 3 Phase.

2—4" Primary and 2—3" Secondary Vortraps.

The above are only a few items of a complete mill. Let us show you the best used equipment available.

OSBORNE PAPER MILL EQUIPMENT CORP.
FULTON, N. Y. **Tel. 2-4254**
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FOR SALE—80" Creper and Waxer complete with Steam Plant. All new equipment. Address Box 53-293 care Paper Trade Journal. TF

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FOR SALE
SPECIAL OFFERINGS

1—24" 4 color Late Type Kidder Celloprinter.
1—74" Oswego Power Paper Cutter.
1—72" Type 10 Model 11 Camachine. Shear-cut.
1—62" Type 28 Model 3-D Camachine. Duplex.
1—62" Type 9 Model 5 Camachine.
1—52" Universal Type 6 Camachine.
1—100" Hamblet Duplex Rotary Sheeter. Mamco Overlap, Erie Layboy and 8 Roll Backstands.
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Inquiries Solicited N-13

FOR SALE—One Beloit Yankee drier reground and coated with bearings and gear for drive by silent chain. Ten foot diameter eleven foot face. Has been drying 55,000 pounds paper daily with forty points steam. Address Box 53-452 care Paper Trade Journal. N-20

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FOR SALE

72" Trim Machine

2 cylinder moulds with vats
2 couch rolls
Suction couch
First press 24" rolls
Second press 18" rolls
39 dryers
2 bowl reel
4 drum winder
Drive, line shaft, pulleys
Foundation plate

Also included:—

3 Rotary Digesters 7' x 19' with drive, used six months.
Green Bay Saveall
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Dilts bandless beater 56x48" with cast iron tub
Impco re-pulper
2—8x6 Oliver filters, stainless steel heads and wire.
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4 Bird consistency regulators, new
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Wallace Tiernan chlorinator
Impco chemical mixer
2 Foote agitator drives, 6—90—150 with 15 HP motors
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Buffalo limit load exhauster, size six, class I.
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2 Frederick centrifugal pumps 200 GPM, 100 ft. head with motors
1 Frederick centrifugal pump 150 GPM, 25 ft. head with motor
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175 RICHDALE AVENUE **CAMBRIDGE 40, MASS.**
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FOR SALE

FOR SALE

One Number 4 Standard Nash Hytor Vacuum Pump with A.C. Motor Equipment. Excellent condition. Address Box #53-468, care Paper Trade Journal.

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FOR SALE

FOR SALE

110" Hamblet Sheeter.
60" Finlay Sheeter.
40" Clark Single Sheeter.
48" Kidder model CH Slitter.
28" Hobbs shear cut Slitter.

BACK-STANDS, ANY SIZE, MADE TO ORDER

Thomas W. Hall Company, Inc.
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(Plant at Stamford, Conn.)

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FOR SALE

1 Fiefield lathe 36" swing—20 ft. bed.

Two 10 h.p. direct connected Aurora boiler feed water pumps, 3 phase 60 cycle 440 and one 300 gallon extra heavy hot water receiving tank.

Address box 53-447 care Paper Trade Journal.

N-27

Paper Trade Journal, Classified Ads Bring Good Results

1—Sandusky Suction Press Roll—162" drilled face x 22" diameter with roller bearings.

FOR SALE

BARKING DRUM
1—10' x 30'.

BEATERS
Write us regarding your requirements.

BREAKER STACK
1—110" face 2 roll braker stack, with frames.

CALENDER STACKS
1—9 roll 68" Calender Stack.
1—4 roll 72" Calender Stack. (Extra heavy duty).
1—3 roll 60" Friction Calender Stack. Two iron rolls and 1 Paper or Cotton Roll.
1—6 roll 86" face.
1—5 roll 90" face.
1—2 roll 150" face, 18" diameter rolls.

CHIPPERS
1—96" Murray 4 knife Chipper—anti-friction bearings.
1—84" Carthage 4 knife Chipper.
1—88" Carthage 4 Knife Chipper.

CLASSIFINER
1—Dilts Classifiner, practically new, with motor.

CORE MACHINE
1—Dietz Core Machine (tube winder).

CRUSHER & HAMMERMILL
1—Murray Chip Crusher.
4—Jeffrey Hammermill.

CYLINDER MOLDS
2—30" diameter x 72" face.
7—36" diameter x 54" face.
2—36" diameter x84" face.
1—30" diameter x 92" face.
1—48" diameter x 117" face.
1—36" diameter x 100" face, anti friction bearings, hollow shaft.
6—36" diameter x 110" face, with 24" diameter, 110" face couch roll.

DIGESTERS
2—14' Globe Rotary Digesters.

DRIVES
1—Jones Reducer 75 h.p.—30.8 to 1.
1—#6½ Reeves Drive.
1—#4 Reeves Drive
1—Vaughn 100 h.p. enclosed drive—ratio 7 to 1.
1—Rice Barton Machine Drives, with clutches, ratio 4:1.
2—Cleveland Agitator Drives for chests.
1—Jones 21 h.p.—Ratio 10:1.

DRYERS
1—Complete unit, consisting of 6 dryers 36" diameter x 38" face, including frames gears, anti-friction bearings.
1—48" diameter x 70" face.
2—Dryers 48" diameter x 134" face.
1—24" diameter x 92½" face.
1—28" diameter x 48" face.
8—36" diameter x 44" face.
1—36" diameter x 67" face.
2—36" diameter x 120" face.
20—36" x 84". Complete.
1—48" diameter x 144" face.
5—28" diameter x 80" face, with anti friction bearings.
8—36" diameter x 72" face.
3—60" diameter x 86" face.
1—48" diameter x 100" face.
1—48" diameter x 106" face.
1—36" diameter x 90" face.
14—36" diameter x 115" face.
8—24" diameter x 60" face, with frames, gears and bearings.
2—48" diameter x 54" face, with bearings.
5—24" diameter x 54" face, with bearings.

EMBOSSING CALENDERS
1—15" 2 roll Embosser.
1—34" 2 roll Embosser (4 sets designed rolls).

EXTRACTOR ROLLS
2—Extractor Rolls, 26" diameter x 105" face, with rubber couch rolls.

FLAT SCREENS
2—12 plate Flat Screens, roller shoes.
2—14 plate Packer.

GEARS
30 gears, for 36" diameter Dryers, 108 teeth 3¼" face.

GRINDERS
2—4 pocket Grinders.
2—3 pocket Grinders.

HEAD BOX AND INLET
1—Valley Iron Works Inlet, complete with head box, 156", all Stainless Steel.

HYDRAFINER
1—Dilts Hydrafiner, with motor.

JORDANS
2—Noble & Wood Mammoth.
1—#2 Emerson anti friction bearing.

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Write us regarding your requirements.

LAMINATING MACHINE
1—72" Hudson Sharp Laminating Machine (reverse coater), with overhead crane.

MOTORS
1—150 h.p. Westinghouse 495 r.p.m. 3/60/440, with starter.
Write us regarding your requirements.

PAPER DUSTER
1—Holyoke Paper Duster, 3 cylinder, 36" diameter x 42" wide, complete.

PRESSES
3—Sets Primary Presses, complete, 145" face. Anti-friction bearings. Also all types of rolls for 145" wet end.

PULLEYS
Various cone and assorted pulleys.

PULPERS
1—Jones Pulper.
1—Lannoye Pulper.

PUMPS
Various sizes of Centrifugal and Plunger Pumps. Write us regarding your particular requirements.

RAG CUTTERS
2—#2 Daniels Rag Cutters.
2—#20 Taylor Stiles.

REELS
1—123"—3 bowl Revolving Reel.
1—134"—2 drum.
1—72" Dowingtown Reel, 2 bowl.
1—86"—2 bowl.
1—84"—3 bowl (revolving).

REFINER
2—#1 Claflin Refiners.

ROLL HEADING MACHINE
1—Montague Header, with Air Cylinders, Heating Element, etc., for up to 36" Dia. x 82" Long Rolls.

ROLLS
1—Rubber Couch Roll—20" diameter x 108" face.
Felt, Table, Press, Breast, Couch, etc. Various sizes and types. (Bronze, Rubber Iron, etc.)

ROTARY SCREENS
Write us regarding your requirements.

SAVEALLS
2—Savealls, 36" diameter x 136" face cylinder molds iron end vats.
1—Pusey & Jones 42" x 146" Saveall.
1—Sandy Hill Saveall, 36" diameter x 100" face cylinder mold (hollow shaft, anti friction bearings, with stainless steel vat, including spare cylinder mold).
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5—Bird Showers 96" face.

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1— 42" Cameron—Type 24-3-A.
1— 42" Cameron—Type 6.
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1— 62" Cameron—Type 40-1-AF.
3— 72" Cameron—Type 10.
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2—86"—2 drum Moore & White (50" dia.)
1—102" Moore & White 4 drum winder.
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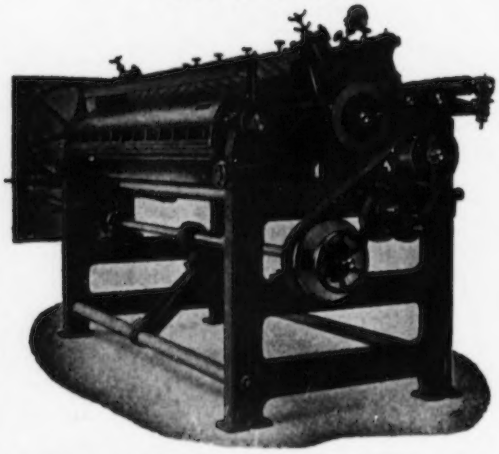

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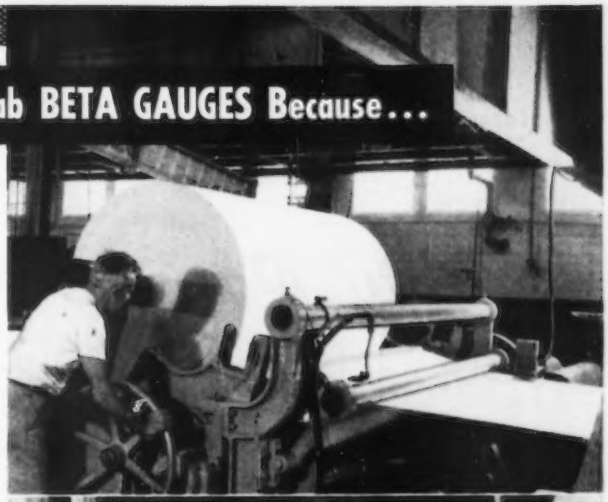

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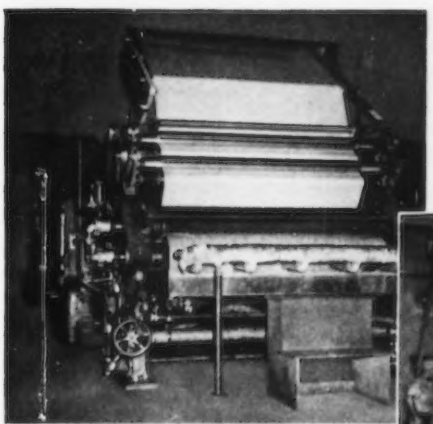

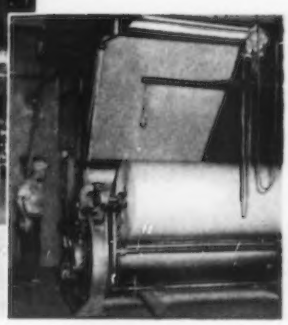

Above:—Unwind Stand of Waldron Gumming Machine. Right:—View of Rewind Stand showing finished product.

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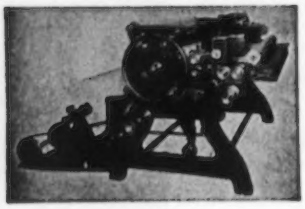

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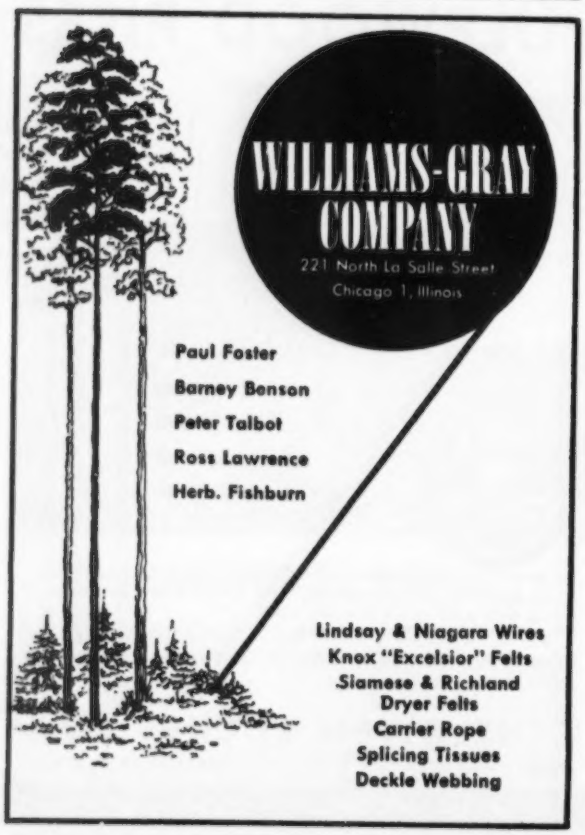

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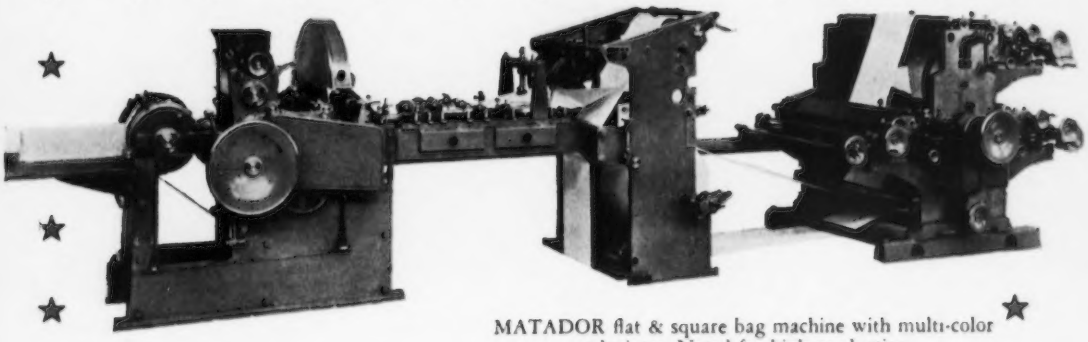

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